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A COMPARISON OF TRAPPING METHODS

BY RICHARD H. MANVILLE

Students of animal populations, wildlife managers, and others are constantly confronted with the problem of estimating the numbers of animals on an area. Usually the area concerned is too large to be investigated completely, and its population is computed from the census of a small sample plot within the larger area. In the case of such inconspicuous and largely nocturnal forms as shrews and rodents, some method of trapping on the sample plot is usually deemed necessary. The question arises as to how accurately the catch on the sample plot reflects the true population over the area as a whole. The study here reported was designed to partially answer this question. It was planned to capture, mark, and release the entire small mammal population of an island. Then sample areas, laid out in various patterns, were to be trapped and the catches thereon compared directly with the known population of the island as a whole.

I am grateful to the late Hon. Chase S. Osborn and to Stellanova Osborn for permission to carry out this work on Little Rogg Island. Don W. Hayne kindly made available live traps and other necessary equipment, and offered much helpful criticism. The study was materially aided by a grant from the All-College Research Fund of Michigan State College.

One common variable in the use of sample plots is the factor of movement of animals from without into the area trapped. This may be due to normal spreading movements toward a recently vacated site, to attraction by the baits used, or to other causes. Furthermore, the sample plot may not typify in all respects the larger area which it represents. The study of an entire island population eliminates these factors. Many studies of island mammals have been made. Blair (1946) estimated the population of beach mice on an entire island, based on a sample area, for the island was too large (nearly 50 miles in length) to be trapped completely. For my work I chose an island small enough to be censused in its entirety.

Little Rogg Island has an area of approximately 9.5 acres; it is 1300 feet long and 500 feet in greatest width. The island is located in Potagannissing Bay, Chippewa County, Michigan—a site near the northern end of Lake Huron. At its southeastern margin Little Rogg Island is separated from Rogg Island by a channel about forty feet in width, but this appears to be an adequate barrier to

small mammals, at least in the summer. Elsewhere the island is isolated by at least a half-mile of open water. The central axis of the island runs nearly north-south (Fig. 1). A narrow fringe of beach encircles the island; for the most part it consists of boulders, cobblestones, and gravel, but in two spots (cross-hatched on the map) there is sandy shore. The remainder of the island was thoroughly burned about 1910. It is now well forested again. White cedar, balsam fir, and aspen are the predominant trees, and there is a good ground cover of various herbaceous plants and duff. A central portion of the island (stippled on the map) contains chiefly aspen and white birch, and here bracken and scattered patches of grass constitute the principal ground cover. The maximum elevation of the island is scarcely more than twenty feet above the level of the bay.

My work was done during July, 1949. In all trapping periods except the last, live traps were employed. These were of two sorts: 84 wire traps of the Burt-Benson type, and 12 sheet metal traps of the Sherman type; the latter were situated at the northern and southern extremities of the island. Dry rolled oats were used as bait. During the final period of three days, snap traps of the "Museum Special" variety were employed, with moistened rolled oats as bait. During the month, 28 small mammals were captured; two were deer mice, *Peromyscus maniculatus gracilis;* the rest were meadow voles, *Microtus p. pennsylvanicus.* The predominance of voles was surprising, especially as the island appeared to be a favorable habitat for *Sorex*, *Blarina*, and *Clethrionomys*. Red squirrels were present, but were not captured in the traps. Some voles were taken as often as eight times during the month (average number of captures, 3+). It is felt that all the resident small mammals, except juveniles still in the nest, were captured during the operations.

As a planned experiment, the study had many bad features. The low initial population of small mammals was unexpected, and it greatly lessened the significance of the findings. Perhaps this resulted from a failure to repopulate the island after the burning. The large proportion of *Microtus* was likewise unexpected; it is possible that the behavior of these voles differed from what we normally expect in their accustomed habitat. Mortality among captured animals, due chiefly to my inability to run the traps more than once (or sometimes twice) per day, was another unfortunate circumstance. The fact that the habitat on the island was not altogether uniform might be criticized, but I believe that this had little effect on the distribution of small mammals in the present instance. Possibly the island chosen was smaller than desirable, but a larger one could not have been trapped so thoroughly; most animals, however, appeared to be restricted to but part of the area. Variations in the weather, the springing of traps by snails or beetles inside, or by red squirrels on the outside, all affected the efficiency of the traps. A longer study than of one month's duration would have been advantageous. This would have permitted leaving the traps idle for a few days between trapping periods, so as to lessen the factors of familiarity with particular traps and attraction to scattered bait, and to allow for a realignment of the animals' home ranges following the removal of some individuals. Also, more time would have favored the use of such variations in technique as the prebaiting of traps (Chitty and Kempson, 1949), the use of supplementary bait in

an effort to reduce mortality (Llewellyn, 1950), the setting of alternate traps on alternate nights, the removal of a specific trap following a capture, the removal

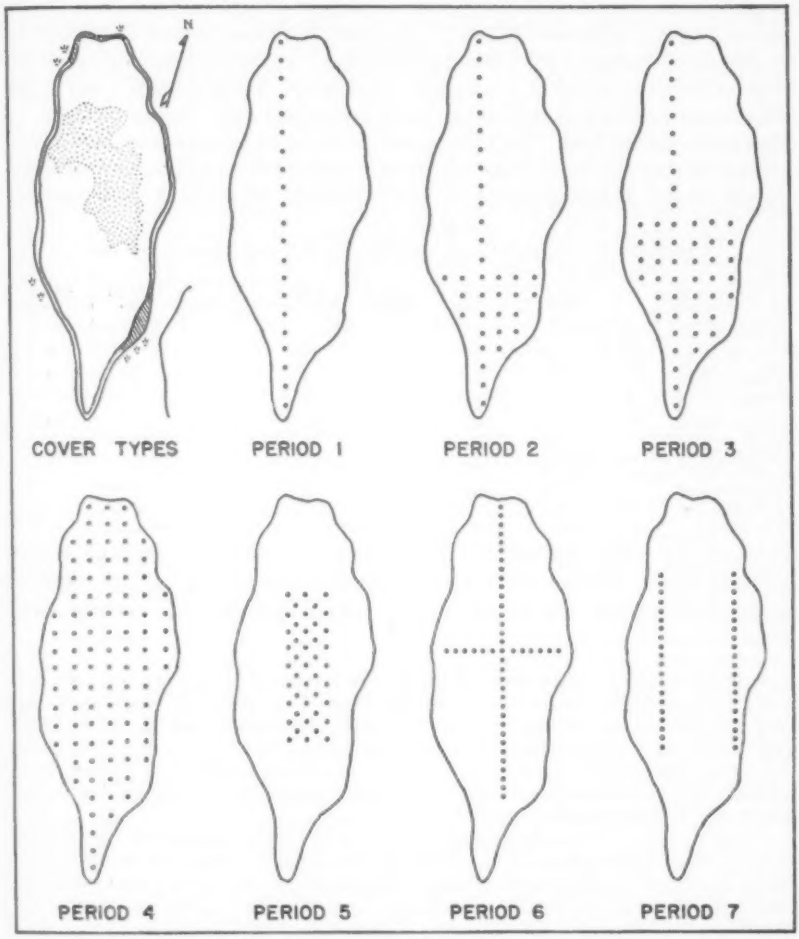

FIG. 1.—Maps of Little Rogg Island showing the general nature of cover and the arrangement of traps during seven trapping periods. In the map at the upper left, the sandy beach (cross-hatched) is distinguished from the rocky shore; the aspen and birch cover (stippled) is shown within the more diverse forest of the rest of the island; and the location of offshore reeds and the proximity to Rogg Island at the southeast are indicated. In the other maps, each dot represents a trapping station.

from the area of the animals themselves (Cahalane, 1941), or the use of such a central, circular plot as was employed by Stickel (1946).

The arrangement of traps during the seven trapping periods is indicated in Figure 1. A summary of the trapping efforts, together with the numbers of adult and subadult *Microtus* which were captured and which died during each period, is presented in Table 1. Only one other vole was taken during the month—a juvenile female, captured on July 30, presumably making its first excursion out of the nest. *Peromyscus* are not included in the table, inasmuch as only two adult females were taken: No. 1 was caught three times, during Periods 1 and 2, on the southern quarter of the island; No. 2 was caught once, during Period 3, at the center of the island. The failure to catch these two mice at later dates is unexplained; they may have fallen prey to a red-tailed hawk observed several times on the island. Trapping success is the percentage captured of those animals

TABLE 1.—*Trapping efforts and captures of adult and subadult Microtus*

TRAPPING PERIOD AND DATES	NO. OF TRAPS	TRAP-NIGHTS	ANIMALS PRESENT	ANIMALS CAPTURED	TRAPPING SUCCESS, PER CENT	ANIMALS DIED	INITIAL CAPTURES
1. July 3–4.....	21	42	25	1	4	0	1
2. July 5–7.....	36	108	25	3	12	2	2
3. July 8–10.....	51	153	23	8	35	2	7
4. July 11–18.....	96	768	21	16	76	9	10
5. July 19–21.....	43	129	12	8	66	1	4
6. July 22–27.....	33, 13	138	11	10	91	4	1
7. July 28–30.....	120	360	7	7	100	7	0

known to have been present at the beginning of each trapping period. Initial captures include all individuals taken for the first time during any one trapping period. The possible significance of these data is discussed in following paragraphs.

Trapping period 1.—The study was begun with a series of twenty-one traps set in a straight line, at 60-foot intervals, along the central axis of the island. In two nights of trapping, one *Microtus* and one *Peromyscus* were caught. Subsequent trapping revealed that twenty-five voles occupied the island at this time; only 4 per cent were captured by the single trap-line. Perhaps the element of novelty contributed somewhat to the low catch, for the voles may at first have been more reluctant to enter traps, as has been observed by Chitty and Kempson (1949) and others.

Trapping period 2.—The checkerboard pattern of traps was started with the addition of fifteen traps at the southern end of the island. Three nights of trapping produced three *Microtus* and the same *Peromyscus* as before. Thus only 12 per cent of the known vole population was accounted for by this arrangement. Two voles died in the traps during this period.

Trapping period 3.—Fifteen more traps were added to the pattern near the center of the island, so that slightly more than half the area was covered by traps set at 60-foot intervals. Three nights of trapping accounted for one new *Peromyscus*, seven new *Microtus*, and the one remaining *Microtus* marked during the previous period. Thus, 35 per cent of the vole population was captured. Two more voles died during this period.

Trapping period 4.—The pattern was completed by the addition of forty-five traps on the northern half of the island. In eight nights of trapping, sixteen voles were captured, ten of them for the first time. Of these ten, however, only six were taken in traps not previously set. New individuals continued to be caught through all eight nights of the period.

At the completion of the trapping, 76 per cent of the vole population on the island had been captured. Five individuals had eluded capture, despite the saturation trapping which totalled 768 trap-nights. Of these five, when subsequently trapped, one proved to be an adult male, and the others subadults, both male and female. All appeared to be moving about over an area including several trap sites. Failure to capture them can scarcely be attributed to prior occupancy of the traps or to a spacing of the traps at too great intervals. Unfortunately, nine more voles died during this trapping period; this doubtless had an effect on the captures in subsequent periods, probably increasing the trapping success obtained later.

Trapping period 5.—A central rectangular area, covering approximately a quarter of the island, was trapped intensively for three nights. Twenty-seven of the traps previously used were left at the same sites, spaced at 60-foot intervals, and in addition sixteen other traps were located midway of the spaces between the original sites, so that no trap was farther than 43 feet from some other trap. Eight voles were captured during these three nights, four of them for the first time, representing 66 per cent of the population still remaining. One animal died in a trap. Possibly the closer spacing of the traps accounted for the high degree of success, although it is difficult to see how this would be the case with only twelve voles known to remain on the island.

Trapping period 6.—This was an attempt to check the plan suggested by Hayne (1949*a*) for estimating small mammal populations. Thirty-three traps, at 30-foot intervals, were located in a north-south direction and were operated on the first, third, and fifth nights of the period. Another line of thirteen traps crossed the center of the first line at right angles, and was operated on the second, fourth, and sixth nights. The critical information for Hayne's computation is the number of animals caught, not merely in one or the other, but in both trap lines. In my trapping, unfortunately, no individual was caught in the two different lines of traps. In the three nights during which each line was operated, eight voles were taken in the north-south line and two in the east-west line of traps. One of the latter had not been previously captured. In five instances voles were caught in traps which were sprung and presumably not in operation. Four individuals died during these operations. Trapping success was high, as the animals caught represented 91 per cent of the eleven individuals known to remain on the island.

Although the data were far from adequate for his purposes, Dr. Hayne was kind enough to estimate the population of voles on the island on the basis of my figures during this period. The problem resolved itself into two parts: the number of voles in contact with the two lines of traps, and the portion of the island effectively covered by the two trap lines. It was computed that about ten voles were exposed to the north-south line, and three to the east-west line of traps. The area covered by the two lines is difficult to estimate, inasmuch as no animal was taken in both lines. One set of evidence indicates that the animals traveled distances of less than 60 feet to the traps; contradictory evidence comes from two individuals captured at points 960 and 270 feet apart. From further evaluation of the sparse evidence, Hayne made the rough approximation of from 24 to 58 voles on the entire island, with the actual numbers probably lying closer to the lower figure.

Trapping period 7.—The final arrangement of traps was designed to follow as closely as practicable the NACSM sampling technique (Calhoun, 1948). Two parallel lines of twenty trap stations, at 30-foot intervals, were located 240 feet apart. Each station contained three snap traps within a circle 3 feet in diameter. The first two nights of trapping accounted for all of the seven voles known to remain. On the third night only one juvenile *Microtus*, not previously captured, was taken.

Dr. Calhoun kindly analyzed my data for this trapping period alone. The decrease in catch from day to day indicated to him that about 45 per cent of the population exposed to traps was being captured each day, i.e. eleven individuals in all were in contact with the traps. Evidence, again contradictory, suggested that the home ranges of individual voles were between 30 and 60 feet in radius. Thus, Calhoun reasoned, between one-third and one-half of the island was exposed to the traps, and the total number of adult and subadult voles was between 22 and 33.

Discussion.—Trapping success, almost without exception, increased throughout the course of the experiment. This probably reflects not only the use of an increasing number of traps, as would be expected, but also the fact that mortality progressively reduced the number of animals remaining. The trapping success did drop by 10 per cent in Period 5, when the traps, although spaced more closely, were concentrated on only a portion of the entire area. Periods 6 and 7 sampled the population along lines, rather than over areas; they appeared to be effective, perhaps partly due to the close spacing of traps. I believe this success was chiefly due to the small number of remaining animals, which possibly moved as individuals over a fair share of the island. The snap traps used during Period 7 may have been a more favorable set than the live traps used previously. The extremely low catch during Period 1, with a single line of traps the length of the island, might be attributed to a wariness on the voles' part of this new situation. There appeared to be no high correlation between trapping success and either number of traps, number of trap-nights, or spacing of traps.

Attempts to compute the island population by the "Lincoln Index" method (Hayne, 1949*b*) were not wholly satisfactory. During Period 4 in particular, when the greatest trapping effort was made, application of this method, even with corrections for known mortality, failed to indicate the true population. This was the case when the entire catch was lumped, as well as when separate computations were made for different sex and age classes. The number of individuals concerned (16) was probably insufficient for this method to work accurately.

During Period 5, approximately one-fourth of the island was under traps and eight voles were captured. On a strict proportionate area basis, this would suggest an island population of 32 voles. If a peripheral zone about the traps were included in the area effectively covered by the traps, in accordance with the suggestion of Dice (1938), the estimate would be considerably lower. Actually the island population at the beginning of the month was 25, but only 12 remained at the beginning of Period 5.

In view of the paucity of the data furnished them, the estimates of both Hayne and Calhoun came remarkably close to the known population on the island during Period 1. Subsequent mortality tended to lessen the significance of the estimates based on data from Periods 6 and 7. I am inclined to feel, however, that the time elapsed since Period 1 was perhaps insufficient for the realignment of home ranges following the removal of certain individuals. In this case, the estimates derived from trapping in Periods 6 and 7 might be expected to lie closer to the original population than to that remaining when the trapping was actually done.

Summary.—All adult and subadult small mammals on a 9.5-acre island were captured during a month of trapping. Twenty-five meadow voles and two deer mice comprised the population. Some voles ranged widely, but most were apparently restricted to but part of the island.

Several different arrangements of traps were used in attempts to estimate the population of the entire island. The small initial population, the short time avail-

able, and in particular the factor of mortality tended to lessen the significance of the experiment.

Trapping success was not altogether a function of either number of traps, number of trap-nights, or spacing of traps. Saturation trapping for eight days and nights failed to capture all the resident animals.

Attempts to estimate the total population, both on the basis of proportion of animals previously captured (Lincoln Index) and proportion of area covered by traps, were not completely satisfactory.

The census methods of both Calhoun and Hayne show considerable promise, although the data secured here were scarcely sufficient for a fair appraisal.

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GROWTH OF THE TESTES AND BACULUM IN THE FUR SEAL, *CALLORHINUS URSINUS*

By Victor B. Scheffer

In 1940 the Fish and Wildlife Service began a study of the anatomy and behavior of marked, known-age Alaska fur seals. The study is still in progress. Its purpose is to obtain information which will be used by the Government in sustaining, and increasing, the revenue from the fur seal herd. Under the auspices of Swarthmore College, Enders, Pearson, and Pearson (1946) issued a report on certain aspects of the reproductive anatomy of the female seal. In the present paper we shall discuss certain gross aspects of the sexual development of the male.

Materials and methods.—Specimens were collected on St. Paul Island, Pribilof Islands, Alaska, in 1940 and from 1944 to 1949 inclusive by Victor B. Scheffer; in 1941 by Ford Wilke and A. Henry Banner; and in 1943 by L. J. Palmer. No research was carried on during the war year 1942.

Study was confined to animals of known age, including: first, late-term fetuses and newborn pups (considered alike, since a fetus recovered on the Pribilof Islands is within a few hours or days of delivery) and, second, seals which had previously been marked in their first summer by a brand or metal tag, and which were recovered later. All materials were collected during the commercial sealing season, June to July (or June to early August). Since this is also the pupping season, the age in years of a given specimen is an integer. Of the eleven yearling seals, one was taken in September and ten were taken in October. These particular specimens are, thus, fourteen to fifteen months old.

Descriptions of modern sealing are given by Carl (1947), Day (1949), and Scheffer and Ashbrook (1949). Briefly, young animals are driven from the beaches, are selected on the basis of size and sex by experienced men, and are clubbed and skinned.

A sample of 178 marked three-year-old males collected in 1944 included animals which were selected by the clubbers as being of commercial size, and which were, therefore, not truly representative of the three-year male class. Certain very small and certain very large three-year-olds were undoubtedly omitted from the sample. In 1945 and in subsequent years the selection of specimens was made by the resident biologist and not by the clubbers.

You will observe in Tables 1 and 3 that the size of the sample for the three-year and the four-year classes is much larger than for any other group. The reasons are, first, that these classes are more readily accessible for sampling and, second, that they are more important from the commercial point of view, and are thus given more attention.

The orientation of the testes and the baculum in the body of the seal is shown in Plate I. As a standard technique, the fresh testes were removed from the tunica and were trimmed with scissors as shown in Plate II. They were weighed and then measured in three dimensions. A few testes of each class were sliced open and preserved in 4 per cent formalin or Bouin's solution and were forwarded

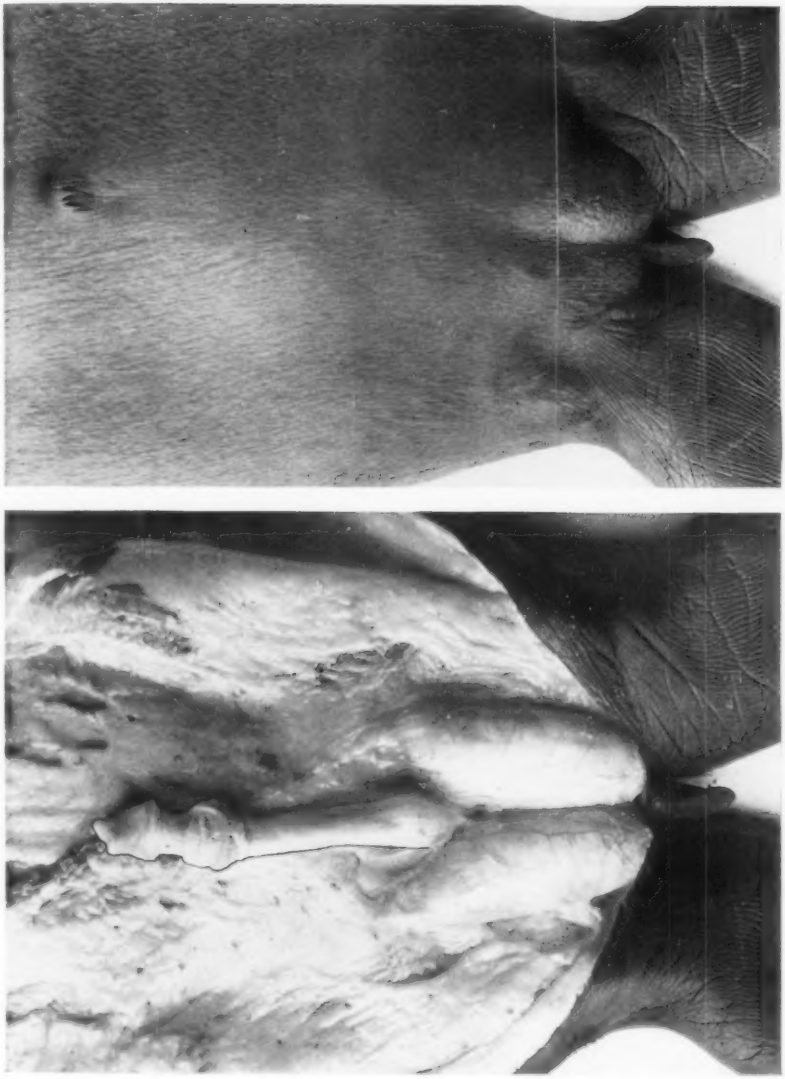

PLATE I

UPPER: External genitalia of 5-year-old fur seal showing penis opening and scrotum; specimen VBS 1349, weight 68 pounds, St. Paul Island, Alaska, 2 July 1949. The testes usually descend between the second and the fourth year.

LOWER: Same specimen; superficial dissection showing penis and testes.

PLATE II

Testes, removed from tunica, of 4-year-old fur seals showing method of preparing testes for study and demonstrating variation in size in animals of the same age. Weight of larger pair, 104 grams; smaller, 14.8 grams.

to Swarthmore College for histological study. Dr. Enders and his colleagues plan to publish at a later date a paper on the microscopic anatomy of the testes, with special reference to spermatogenesis. The dimensions of the testes are omitted

from the present paper because we feel that the weights alone adequately represent the development of these organs.

The bacula (Pl. III) were treated experimentally in a variety of ways. Some were frozen or dried on the Pribilof Islands and were subsequently cleaned of

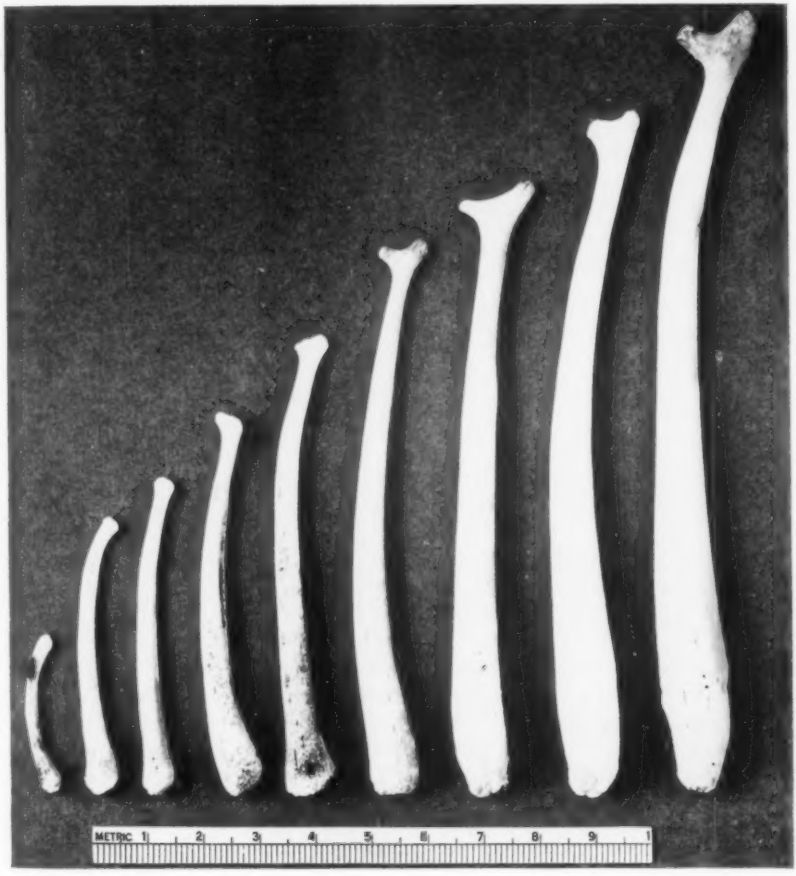

PLATE III

Representative bacula of fur seals ranging in age from newborn to 8 years. The ruler is 10 cm. in length.

flesh by (1) dermestid beetles, or (2) boiling in dilute ammonium hydroxide, or (3) boiling in saturated calcium hydroxide. Others were placed while fresh in the waters of St. Paul Harbor where they were partially cleaned by scavenging amphipods. Had a satisfactory technique of cleaning bacula been developed at

the start of the study, we should have reported baculum size by weight rather than by length. As it is, the bacula contain varying percentages of oil and organic matter, depending on the treatment they received, and are thus not comparable on a weight basis. All of the bacula have been saved.

Results.—Using the gross development of the testes as a criterion (Table 1 and Fig. 1), it is now apparent that male fur seals can be divided into three groups: (1) juvenile, from birth to age 3 years; (2) adolescent, ages 4 and 5 years; (3) adult, from age 6 to death. (The maximum age which the male attains is not known although it is probably more than twenty years. Harry J. Christoffers (1940) saw three healthy bulls which had been hot-iron branded 15 years previously when they were approximately three years of age. Positive information on longevity will be available in the 1960's when the survivors of 10,000 seal pups, both branded and tagged in 1941, shall have reached the end of life.)

TABLE 1.—*Weight of the testes in fur seals ranging in age from newborn to 8 years*[1]

AGE	NO.	RANGE	ARITHMETIC MEAN	GEOMETRIC MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Newborn[2]	7	2.3–3.2	2.6	2.6	0.2	10.3
1 year	1	3.2	—	—	—	—
2 years	24	6–17	11.7	11.2	3.1	26.8
3 years	111	8–70	21.9	19.2	11.8	54.2
4 years	150	14–104	55.6	51.9	18.2	32.7
5 years	26	38–106	79.0	76.6	17.9	22.7
6 years	22	64–138	94.2	92.4	18.3	19.5
7 years	6	76–126	103.6	101.6	19.7	19.0
8 years	4	93–129	111.2	110.5	25.6	11.5

[1] Weight in grams of the fresh testes; samples from animals of known age collected from July to August (yearlings from September to October) on St. Paul Island, Alaska.
[2] Newborn pups and full-term fetuses.

Variability in the weight of the testes within a given age class rises to the third year and then falls (Table 1). The third year class is on the threshold of puberty with many of its members definitely juvenile, others adolescent.

The rate of development of the testes, as indicated by the trend of the curve in Figure 1, suggests that the male fur seal reaches prime condition in about the tenth year. It is likely that he is both physically and sociologically prime as a ten-year-old. The biologists observe on the breeding grounds that, although a few six- and seven-year-olds may win a small harem on the margin of the rookery, mating as a rule is consummated by the older, more experienced males which are able to hold their respective stations in the midst of the highly competitive social organization of the seal rookery. As a matter of convenience in keeping an inventory of the fur seal herd, the Fish and Wildlife Service has traditionally classified males of ages two to six as "bachelors;" those from age seven onward as "bulls."

The largest testes from a known-age seal weighed 131 grams (from the single 9-year-old specimen in our collection), while the largest testes from any seal

weighed 151 grams. The latter were from a prime bull weighing 613 pounds, collected in late May. These values may be compared with the mean weight of the 8-year testes, or 110.5 grams.

Seasonal variation in the size of the testes is not demonstrable. We find that there is no significant difference in the mean weight of the testes in the earlier-collected half and in the later-collected half of the 4-year-old specimens. The evidence at hand, however, suggests that within a given year class of seals the nd ividuals with longer bodies and larger testes haul out on land earlier than do

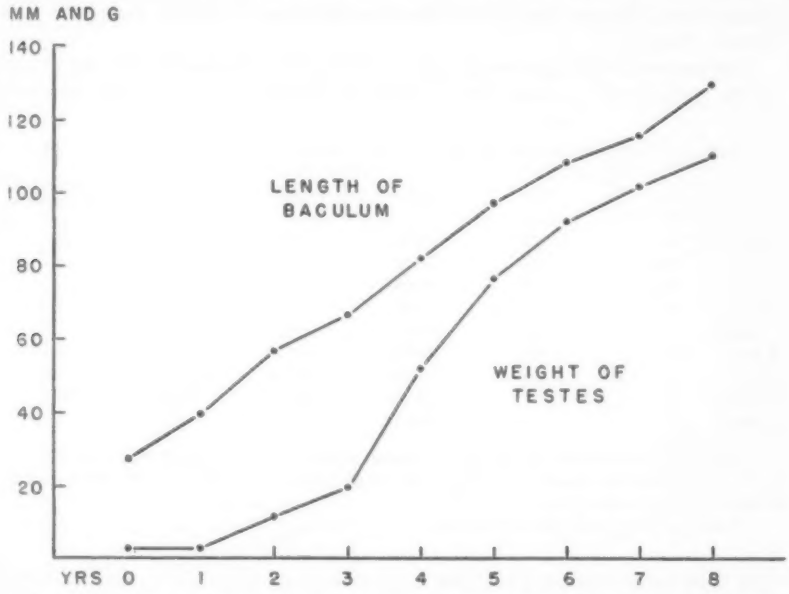

FIG. 1.—Weight of testes and length of baculum in fur seals ranging in age from newborn to 8 years. (From data in Tables 1 and 2. The geometric mean is used for testes weight; the arithmetic mean for baculum length. The yearling specimens were nearer 15 than 12 months of age and as a consequence the datum point representing this year-class has been plotted at 12/15ths its observed value.)

their fellows. Data accumulating within the next three years from tagged animals may confirm the significance of this relationship.

Incidentally, we have examined the testes of four cryptorchid seals. Cryptorchids, known to the Pribilof employees as "big cows," are rarely seen. They have the long body and limbs, but lack the great muscular neck pad and grizzled mane of the normal bull. Their slender bodies give them an ungainly appearance and an awkward stance. The largest specimen we have examined weighed 329 pounds, or three times the weight of a cow and half the weight of a bull. In the cryptorchid, each testis weighs from 4 to 10 grams.

A knowledge of the age at which the male fur seal becomes sexually mature is of practical value. The male visits the Pribilof Islands for the purpose of breeding. The date of his arrival in early summer, in other words his availability, is closely linked with the success of the commercial sealing operation. It now appears that the average three-year-old is distinctly juvenile. Thus, one can deduce that the stimuli which bring him to land are less powerful than the sex stimuli which bring the four-year-old. And, continuing this line of reasoning, weather conditions which deter the juvenile from landing may not deter the adolescent. The deduction may be used as evidence in favor of shifting the present specifications of the "killable class" of seals in the direction of a slightly larger and more mature animal.

The baculum.—The growth in length of the baculum during the first eight years of life appears to be almost linear (Table 2 and Fig. 1). We suspect, however,

TABLE 2.—*Length of the baculum in fur seals ranging in age from newborn to 8 years*[1]

AGE	NO.	RANGE	ARITHMETIC MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Newborn[2]	13	23–35	27.3	3.6	13.1
1 year	11	42–55	49.4	3.3	6.7
2 years	24	48–68	56.6	4.9	8.7
3 years	111	53–80	66.5	5.2	7.8
4 years	150	69–99	82.2	6.4	7.8
5 years	27	77–115	97.0	7.7	8.0
6 years	21	94–120	108.4	5.6	5.1
7 years	6	112–126	116.1	4.7	4.1
8 years	4	124–137	130.0	6.0	4.6

[1] Length in millimeters of the dry baculum; samples from animals of known age collected from July to August (yearlings from September to October) on St. Paul Island, Alaska.

[2] Newborn pups and full-term fetuses.

that when measurements from older animals become available we shall find that growth follows the logistic curve. The first eight years represent only one-half to one-third of the estimated maximum life of the seal, and the growth rate of the baculum probably declines in the later years. The largest baculum in our collection of 58 specimens from bulls of unknown age measures 147 mm. as compared with the largest known-age baculum, a 137-mm. specimen from an 8-year-old. Since the baculum develops at a fairly steady rate throughout life, and does not exhibit accelerated growth during adolescence, the growth curve (Fig. 1) of this bone does not furnish evidence as to the time and duration of adolescence.

After the first summer, variability in the length of the baculum within a given age class is small and fairly uniform (Table 2). It seems to decline slightly in the older seals, although for these we have few specimens from which to draw conclusions.

Exploring, we applied Walford's (1946) "graphic method of describing the growth of animals" to the mean observations of baculum lengths in seals of ages

2 to 8 years (Table 2). The method seems to be inapplicable here, as the plotted points are found to lie on a curve rather than on a straight line.

On the basis of values for length of baculum, as displayed in Table 2, we have prepared standards which may be used in estimating the age of a male seal collected from mid-June to mid-August. These are: 23–38 mm., newborn; 39–51 mm., 1 year (September–October specimens); 52–61 mm., 2 years; 62–73 mm., 3 years; 74–88 mm., 4 years; 89–104 mm., 5 years; 105 and over, 6 years and over.

In establishing the boundary between two adjacent age classes, A, the smaller, and B, the larger, we have used a value midway between the values (mean of A

TABLE 3.—*Length of the baculum in fur seals collected on certain killing fields of St. Paul Island in 1949*[1]

LENGTH, MM.	FREQUENCY	
	Sample of 29 June[2]	Sample of 26 July[3]
51–55	0	5
56–60	4	21
61–65	45	76
66–70	104	133
71–75	83	123
76–80	75	82
81–85	96	31
86–90	44	14
91–95	19	3
96–100	6	1
101–105	3	0
Total	479	489

[1] The seals were killed selectively for size, that is, for the seal-skin market; while the bacula were collected at random from their carcasses.

[2] Out of 513 seals killed.

[3] Out of 2545 seals killed.

plus twice its standard deviation, and mean of B minus twice its standard deviation).

The shortest and lightest baculum in our collection, from a newborn pup, is 23 mm. in length and weighs 0.096 grams. The heaviest is 136 mm. in length and weighs 14.5 grams. It is from a bull carcass recorded in our field notes as being "very old." Thus, the baculum of the mature fur seal may be over 1500 times as heavy as that of the newborn pup. We know of no other mammal having a bone which grows so enormously during the lifetime of the individual. The baculum of some other pinniped may perhaps be an exception. We once examined a walrus baculum measuring 622 mm. (24.4 inches) in length and weighing 966 grams (2.13 pounds).

The typical fur seal baculum is illustrated in Plate III. Rarely, the baculum has one or two short accessory spurs or projections near the tail end (distal end). In five cryptorchid seals, the bacula measure 76, 89, 112, 115, and 131 mm. in

length, and all but one are unusually slender. In a bachelor seal exhibiting hypospadias, the baculum is about two-thirds its normal length and is curved like a surgical needle. We have previously described (1949) the clitoris bone, analogue of the baculum, which appears on rare occasion in the fur seal.

With information at hand on the relation of the length of baculum to the age of the seal, we analyzed two regular killings on St. Paul Island to determine the probable age of the animals (Tables 3–4). The probable age has traditionally

TABLE 4.—*Length of the body in fur seals collected on certain killing fields of St. Paul Island in 1949*[1]

LENGTH, INCHES	FREQUENCY		
	Estimated Age, Years	Killing of 29 June	Killing of 26 July
38	2	1	1
39	2	3	5
40	2	8	44
Subtotal		12	50
41	3	85	402
42	3	97	598
43	3	91	608
44	3	85	463
45	3	91	306
Subtotal		449	2377
46	4	17	87
47	4	17	26
48	4	10	5
49	4	6	0
50	4	1	0
51	4	1	0
Subtotal		52	118
Total		513	2545

[1] The seals were killed selectively for size, that is, for the seal-skin market.

been determined by measuring the total length of the freshly killed animal. That is, since 1918, the length of every male seal killed on the Pribilof Islands has been measured as a commercial routine, and the length has been converted into probable age by means of age-length standards established between 1913 and 1918. Our experimental approach was to use the length of baculum rather than the body length as an age index. We analyzed an early-season kill on 29 June and a late-season kill on 26 July.

The results are shown graphically in Figure 2. In the early season kill, the frequency polygon representing baculum lengths is strongly bimodal, indicating, we believe, 3-year-old and 4-year-old seals. According to the evidence of baculum

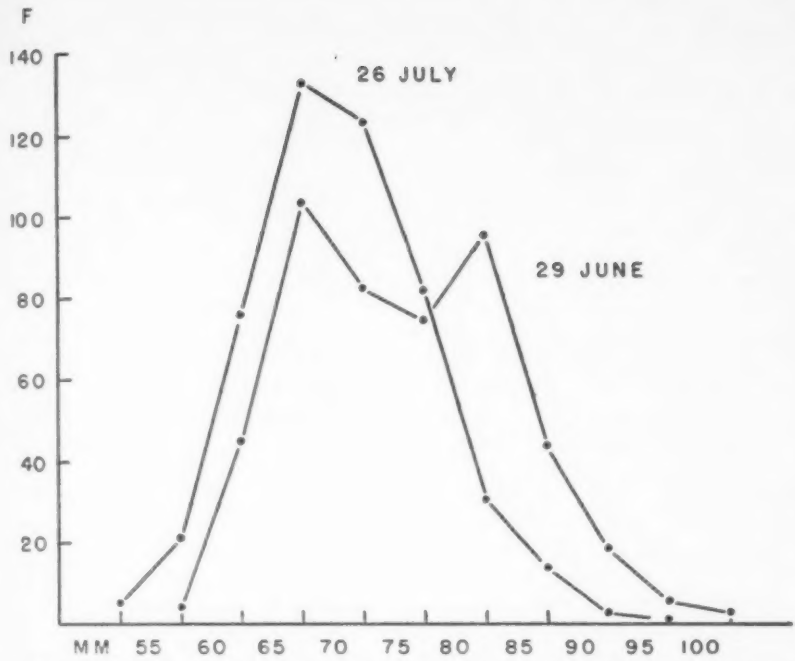

FIG. 2.—Length of the baculum in fur seals collected on the killing fields of St. Paul Island in 1949. (From data in Table 3. *Early season sample* of 479 bacula out of 513 seals killed, 29 June; *late season sample* of 489 bacula out of 2545 seals killed, 26 July. The seals were killed selectively for size; the bacula were collected at random from these seals. The distribution of baculum lengths as shown may be compared with the mean baculum length of known-age seals, that is: 2-year-olds, 56.6 mm.; 3-year-olds, 66.5 mm.; 4-year-olds, 82.2 mm.; and 5-year-olds, 97.0 mm.)

TABLE 5.—*Comparison of two estimates of the ages of killing-field seals*[1]

ESTIMATED AGE, YEARS	PERCENTAGE REPRESENTATION OF EACH AGE CLASS IN THE KILLING	
	On the Basis of Body Length	On the Basis of Baculum Length
	Early season killing, 29 June	
1	0.0	0.0
2	2.4	2.1
3	87.5	41.8
4	10.1	46.1
5	0.0	10.0
All	100.0	100.0
	Late season killing, 26 July	
1	0.0	0.2
2	2.0	6.1
3	93.4	57.3
4	4.6	35.0
5	0.0	0.0
All	100.0	100.0

[1] The seals were killed selectively for size, that is, for the seal-skin market.

analysis, the 4-year class contributed a substantial portion, or 46 per cent of the day's kill (Table 5). On the other hand, the routine breakdown of the kill into age classes by means of the body-length standard would lead one to believe that 4-year-olds were unimportant, constituting only 10 per cent of the kill.

As regards the late season kill, a quick examination of Figure 2 would lead one to believe that the kill included 3-year-olds and little else. Application of the baculum-length standard, however, suggests that 35 per cent of the seals killed were actually 4-year-olds (Table 5). We are inclined to trust the evidence of baculum length, in view of its comparatively low variability, over that of body length. Body length, as customarily measured, depends greatly on the degree of contraction of the neck of the seal at the time of death, and upon the position of the carcass as it lies in the grass. We hope to gather evidence of a more conclusive nature in the near future by sampling the teeth, as well as the bacula, of killing-field seals. Growth rings around the bases of the canine teeth apparently indicate the true age (up to perhaps 8 years) of a fur seal.

Summary.—On the basis of the gross development of the testes and baculum, male fur seals fall into three groups: juvenile (ages 1 to 3 years), adolescent (ages 4 to 5 years), and adult (ages 6 to 18 years or more). The male reaches prime condition as a breeding animal in about the tenth year. Variability in testes weight is greatest in the third year. From adolescent seals, the testes collected in June are not significantly larger than those collected in July. Variability in length of baculum is not marked. The growth of the baculum seems to progress at a steady rate, before, through, and after puberty, and to this extent does not resemble the growth of a secondary sex character. The distribution of bacular lengths is evidence of the distribution of ages in commercial killings. Indications are that baculum sampling may become an important new tool in analyzing the age composition of the killings.

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HISTOLOGICAL ASPECTS OF THE GLANDS OF THE BAT, *TADARIDA CYNOCEPHALA* (LECONTE)

By H. J. Werner, W. W. Dalquest, and J. H. Roberts

The presence of both glands and glandular tissue in various parts of the bodies of North American bats has been mentioned by several investigators. With the exception of the work of Harrison and Davies (Proc. Zool. Soc. London, 119:331–357, 1949), on the facial glands of the European bat, *Noctula noctula*, studies of a histological nature to determine the type and the probable functions of such tissues seem to be lacking.

The work of Harrison and Davies prompted us to begin a study of the glands of some North American bats. The form reported on here, *Tadarida cynocephala*, is a member of the family Molossidae. A few salient differences have been observed in the glands of the face of this species, as compared with Harrison's and Davies' description of the facial glands of *Noctula noctula*, which belongs to the family Vespertilionidae.

Materials and methods.—Specimens, including both males and females, were collected in Baton Rouge, Louisiana. Tissues were fixed in either Bouin's or Aceto-Zenker's solution depending upon the subsequent stain. All the tissues were dehydrated by means of various concentrations of ethyl alcohol, cleared in cedar oil, and embedded in paraffin. Serial sections were cut at five microns and stained as follows: Harris' haematoxylin with an alcoholic eosin counter stain, Heidenhain's modification of Mallory's connective tissue stain (Azan), Heidenhain's iron haematoxylin, the Feulgen reaction, and Lillie's iron haematoxylin and metachromatic dyes.

The first stain is conducive to an over-all examination of the tissues. The azan method was used for identification of connective tissue patterns. The third and the fourth methods were of value because they are, respectively, specific for nuclear patterns and chromatin material. Lillie's metachromatic dye-method was used to detect the presence or absence of mucin within the cells. As a check of the effectiveness of this dye, cartilage was always stained simultaneously, along with the tissue.

Discussion.—Two types of facial glands were found, namely, sebaceous and salivary glands. The former are holocrine glands, the secretion of which is derived from the degeneration of the cells of the gland itself, and is eventually expelled onto the skin of the bat. Harrison and Davies (*loc. cit.*) separated these glands in *Noctula noctula* on the basis of their location into pararhinal glands (on the muzzle) and submental glands (beneath the lower jaw). Glands similar to these were found in the corresponding body regions of *Tadarida cynocephala*, but they were also found elsewhere on the body of the bats. These glands are the etiology of the strong, unpleasant odor and the oily pelage of *Tadarida*.

The salivary glands consist of three distinct pairs of glandular masses. One pair is located in the muzzle, above the upper jaw, and empties by means of a large duct into the inner side of the upper jaw, distal to the mandible. The second pair of glandular masses, located in the lower jaw, empties onto the mandibu-

lar surface of the mouth. The third pair of salivary glands lie freely between the skin and the muscles of the neck, just posterior to and beneath the corner of the jaw. These glands empty, each by a single large duct, into the corner of the mouth on the ventral, lingual side of the mandible.

Harrison and Davies (*loc. cit.*) described a gland in *Noctula noctula* which they named the Buccal Pad. This gland is not present in *Tadarida cynocephala*.

Plate I, upper left, illustrates a typical sebaceous gland from the epithelium of the upper lip of *Tadarida cynocephala*. This is an instance of an isolated gland in association with one of the smaller hair follicles. It is a holocrine gland, the inner cells of which, as the figure plainly shows, undergo periodic degeneration. The products of cellular degeneration, which include the nuclei, enter the adjacent hair follicle. This fluid and debris are the secretion of the gland.

The variation in the hairs of the muzzle of *Tadarida* has been mentioned by Miller (U. S. Nat. Mus. Bull. 47, 1907), who speaks of "horny points" and "stiffened spoon hairs." Microscopic examination of the hairs of the muzzle of *Tadarida cynocephala* shows variation in extremes of size, ranging from greatly narrowed and delicate hairs to greatly thickened spines, capable of piercing human skin. Sebaceous glands are invariably found in rather intimate association with the bases or lateral areas of the hair follicles. The single glands are contiguous with the smaller hairs, while the larger glandular areas, of which Plate I, upper right, is an example, are found in the vicinity of the bristle-like hairs. These large sebaceous areas are subdivided into lobes and lobules by the septa sent in by the surrounding connective tissue. The cells along the periphery of each lobule rest on a delicate basement membrane. In Plate I, upper right, this membrane is masked by the azan technique which was here used to demonstrate the connective tissue pattern. The individual cells of these areas are irregularly polyhedral in outline. The cells along the periphery of the lobules represent the youngest cells in origin. Their shape more nearly conforms to that of enlarged squamous cells. As each cell migrates inward, toward the center of the lobule, it becomes more polyhedral in shape. The nuclei, in most instances, are in the center of the cells. This position of the nucleus, in relation to the cell boundary, is indicative of a serous type secreting cell. The nuclei and the cytoplasmic contents of the cells of each lobule become progressively less distinct as the cell reaches the interior of the gland. It is as though a process of metabolic disintegration is going on, in anticipation of actual degeneration prior to elimination.

Plate I, lower left, is a longitudinal section through a large bristle. It shows the relationship between a sebaceous gland and its large follicle. As pointed out by Harrison and Davies (*loc. cit.*) one can trace the downward course of squamous, stratified epithelium of the epidermis to the main duct of the gland, at which point it abruptly stops.

Plate I, lower right, depicts a cross section through a large hair follicle. Surrounding the follicle and glands there is a layer of striated muscle, from which delicate muscular septa extend inwardly. Among the latter, one sees the abundant cellular debris which represents the secretion of the holocrine gland. These muscular strands probably aid in expelling the secretion onto the epithelial surface.

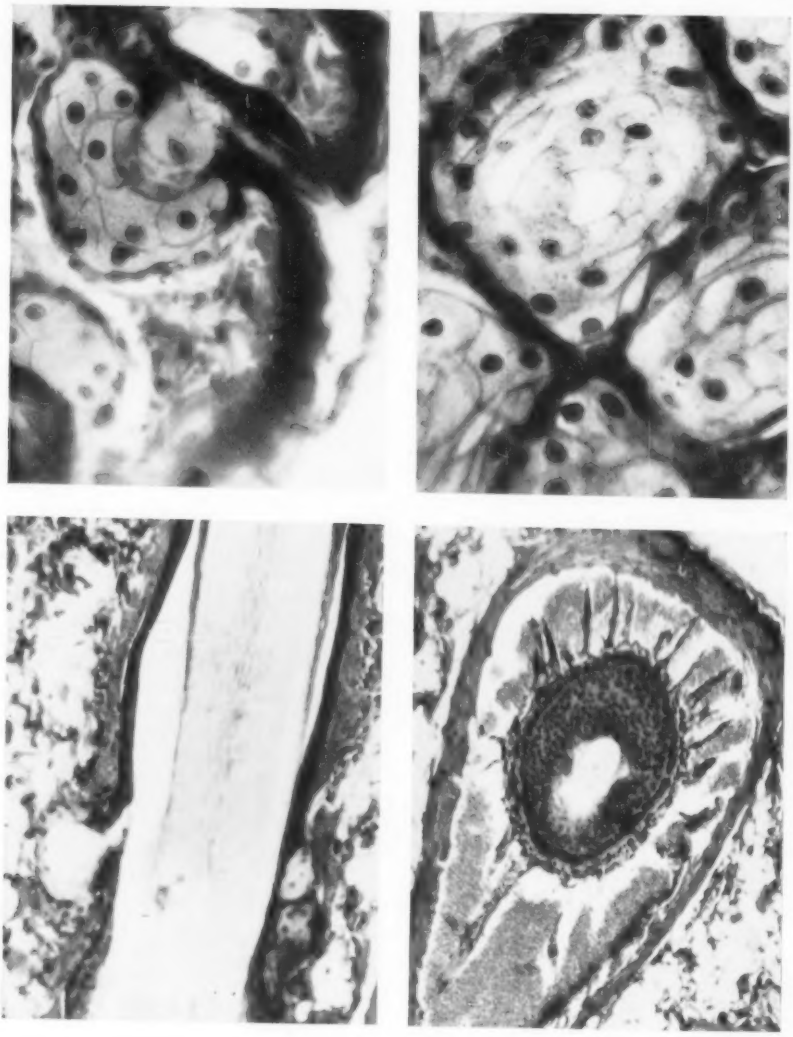

PLATE I

UPPER LEFT: Section through sebaceous gland to show holocrine activity, about × 450.

UPPER RIGHT: Section through sebaceous gland to show histological details, about × 450.

LOWER LEFT: Longitudinal section through large hair follicle to show opening of sebaceous glands along follicle, about × 100.

LOWER RIGHT: Cross section through large hair follicle to show holocrine secretion and muscular and connective tissue septa, about × 100.

One pair of the salivary glands from the upper lip of *Tadarida cynocephala* is shown in Plate II, upper right and left, and lower left. Plate II, upper left, gives an overall picture of the circumscribed mass of this serous type gland. Connective tissue, with its penetrating septa, can be seen surrounding the gland. The

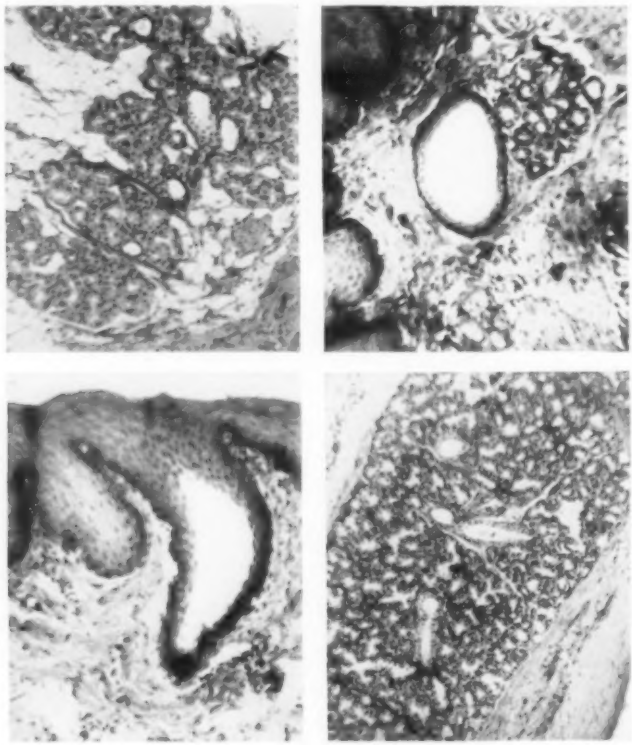

PLATE II

Upper Left: Section through salivary gland of upper jaw, about × 100.
Upper Right: Section through same salivary gland with its common duct, about × 100.
Lower Left: Section to show the opening of this same gland onto the labial surface, about × 450.
Lower Right: Section through the salivary gland of the lower jaw, about ×100.

cells of this gland are roughly polyhedral in shape; the nuclei are centrally situated; the cytoplasm is granular and eosinophilic in stain reaction. The cytoplasm of all these cells is negative in reaction to the metachromatic stains for mucin. Plate II, upper right, is a different portion of the gland with its adjacent common duct. Plate II, lower left, shows the common duct opening onto the oral epithelium of the labial surface—the only gland, salivary or sebaceous, opening onto this surface.

The second pair of salivary glands, one of which is shown in Plate II, lower right, is found in the lower jaw epithelium. This gland is in all respects histologically similar to the above described salivary glands. These bilaterally disposed glands are situated deep in the dermis and are much more extensive than any other glandular tissue on the epithelial surface of *Tadarida cynocephala*.

The third pair of salivary glands lies freely between the skin and muscle, posterior and ventral to the bases of the ears and corners of the jaw. These glands are ovoid in shape, flattened dorso-ventrally, and translucent. Average measurements are: length, 5 mm.; width, 4 mm.; and thickness, 2 mm. These glands are weakly adherent to the musculature by means of delicate strands of fascia. Thin threads of fascia also extend from the gland to the epidermis. A relatively large, strong duct runs anteriorly and dorsally from the substance of the gland, penetrating the musculature, to empty onto the lingual surface of the mouth, ventrad to the corner of the jaw.

To judge by the position of these salivary glands, and their ducts, we would suppose that the pair of glands in the lower jaw represents the sublingual gland, and the pair of glands below and behind the ears corresponds to the submaxillary gland. We hesitate to apply any definite name to the glands of the upper lip. They may represent the parotid glands.

The abundance of sebaceous glands on the face of *Tadarida cynocephala*, and over the body, may be confined to the family Molossidae. Certainly the members of this family are among the most strong-smelling of bats. The value to the bat of this strong odor or of the oily secretion of the glands is unknown. *Tadarida* is a highly colonial form, and the odor may serve to make known to other bats the location of the daytime retreats of the colonies.

Summary.—Two types of glandular tissue were found in the face of *Tadarida cynocephala:* sebaceous and salivary. The former is found singly, in association with small hairs, and in clusters in association with the larger hairs. These are holocrine glands whose ducts open into the hair follicles.

Three pairs of salivary glands are present. On the bases of the negative reaction to the specialized metachromatic stain, and the histological picture previously described, these glands are all of the serous variety. Nowhere in the upper or lower epithelium of *Tadarida* have mucous cells or mixed (serous and mucous) glands been found.

Sudoriparous glands described as being present in *Noctula noctula* are not distinguishable in *Tadarida cynocephala*.

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A TEXAS COLONY OF BATS, *TADARIDA MEXICANA*

By Fred R. Cagle

The bat population of Ney Cave, near Bandera, Texas, has been reported as being the largest in the United States. The cave and the remarkable daily bat flights have been amply described (Mohr, 1948; Stager, 1948; Moore, 1949), but only limited information is available on the bionomics of the Mexican free-tailed bat which comprises the greatest part of the colony.

This cave has provided a source of guano since the Civil War, and still produces 20–30 tons each year. Guano harvesters report that there has been an annual decrease in the quantity taken and an apparent decrease in the number of bats.

The bats have been observed daily for more than twenty years by Mr. Gerdes, a rancher living in the valley below the cave entrance. He stated that the bats leave the cave in September or October and return in March or April. The guano is removed while the bats are absent. It could not be determined whether the bats moved to another locality or merely to deeper parts of the cave.

Data on the bat population were collected incidental to the instruction of students of the Audubon Nature Camp of Texas in six visits to the cave during June, July, and August of 1949. Limitations of time and equipment required that the procedures for collecting data be simple. It was desired to obtain information on: sex ratio, size at birth, growth rate, size at first flight, mortality rate of juveniles, and the contribution of the young of the year to the total population. It was thus essential that the data include a measure of size and an approximation of age.

The length of the forearm was selected as a criterion of size, not because it best reflects the total mass of the individual, but simply because it could be measured rapidly and accurately under field conditions. All measurements were made with a Vernier caliper with the wing held in a half folded position. Juveniles were separated from adults on the basis of three factors; color of pelage, status of growth of metacarpals, stage of development and degree of wear of teeth. Young of the year have a dark gray pelage that was consistently correlated with incompletely fused metacarpals and incompletely erupted or unworn teeth.

Wall samples of young were taken at random in the cave except on the last visit when a deliberate attempt was made to select the youngest bats. Flight samples were taken with butterfly nets from the mass of bats emerging from the cave entrance. Air temperatures were recorded with a thermometer accurate to .2° C.

Air temperatures within the cave varied from 23.2° C. to 34.2° C.; the temperature was highest when the main flight was leaving the cave. The temperature of the rock surface just under masses of young was repeatedly recorded as 38° C.

The first young bats were observed in the cave June 25. One area of wall ten feet square held a solid mass of newborn individuals. No young bats had been observed on a previous visit to the cave, June 11. No measurements were recorded on this first group of young, but it was observed that they were quite

uniform in size. The majority of the adults had left for the evening flight. The three adults present were suckling young.

A wall sample of juveniles taken July 9 yielded 70 males and 44 females. The forearm measurements of the males varied from 1.82 cm. to 3.57 cm.; average, 2.68 cm.; females varied from 1.76 cm. to 3.46 cm.; average, 2.70 cm. Three of the smallest individuals still retained a section of the umbilical cord. The collection of juveniles made July 15 contained one individual with the placenta attached. The forearm length was 1.80 cm. No individuals of this size were observed after July 15. It thus appears that the bulk of the bats were born during the period from mid-June through the first week of July. Davis (1944) reported finding a colony of females, each one containing a nearly full-term foetus, June 5–12 at the Rio Ramos, Mexico.

The young bats increase rapidly in size. The mean size of males increased from 2.68 cm., July 9, to 4.08 cm., August 5; mean size of females from 2.70 cm., July 9, to 3.98 cm., August 5 (Table 1).

TABLE 1.—*Increase of forearm length in juveniles*

DATE	MALES			FEMALES		
	Number	Range	Average	Number	Range	Average
July 9	36	1.82–3.57**	2.68	27	1.76–3.46	2.70
July 15	57	1.92–3.83	3.22	46	1.80–3.86	3.12
July 30	21	2.73–4.27	3.87	30	2.12–4.47	3.74
August 5	25	3.38–4.32	4.08	26	3.25–4.34	3.98
August 13	*10	3.09–4.30	3.76	*15	3.70–4.24	3.99

* Selected samples. ** Measurements are in centimeters.

The bats are suckled by the females until they are large enough to join the flight. Of 92 juveniles collected from the cave walls (July 9, July 15, July 30) and examined by dissection, the largest to contain milk in the digestive tract had a forearm length of 4.24 cm. No smaller bats contained insects.

Those collected on July 9 and July 15 all had the stomachs inflated with milk, but eight of 32 collected July 30 were empty. These eight, all larger individuals collected at 11:30 P.M. after the adults had left for the evening flight, varied in size from 3.96–4.37 cm. It is of significance that the smallest individual with an empty stomach was large enough to join the regular flight. Both the stage of tooth and pelage development were similar to that of the smallest bats participating in the flight.

The smallest bats collected from the flights had forearm lengths of: males, July 30, 4.10 cm.; August 5, 4.07 cm.; August 13, 4.08 cm.: females, July 30, 4.12 cm.; August 5, 4.12 cm.; August 13, 3.91 cm.

None of the juveniles collected prior to July 30 had attained a forearm length adequate to permit them to participate in the evening flight, but 31 of 51 measured July 30 had forearm lengths in excess of 3.91 cm. (Table 1).

Although it was not feasible to measure large numbers of juveniles it was possible to sex series adequate for approximating the sex ratio. Of 461 juveniles

sexed, 246 were males and 215 were females. The sex ratio of juveniles was in startling contrast to the sex ratio of individuals participating in the evening flight. The first flight sample taken July 9 included only adult females. Of 260 sexed from the flight on July 30, 209 were females and 51 were males. All of the males were juveniles, but the females were not identified as adults or juveniles. The August 5 flight sample of 277 was composed of 113 juvenile males, 93 juvenile females, and 71 adult females. Flight samples taken on August 13 yielded 59 adult females, 23 juvenile females, and 44 juvenile males. Of 680 bats examined from evening flights, 208 were juvenile males, none were adult males, 116 were juvenile females, 147 were adult females and 209 females were not segregated as juveniles or adults.

The preponderance of juveniles in these flight samples (273 juveniles to 130 adult females) of August 5 and 13 may be a reflection of a changing composition of the flight as the bats emerge. Timed samples suggest that the adults leave the cave earlier and in a more spontaneous, concentrated flight. A sample taken at the beginning of the August 5 flight, from 7:35 to 7:50, contained 29 adult females, three juvenile females, and 23 juvenile males; a sample taken at 8:00–8:15 P.M. yielded 43 adult females, 90 juvenile females, and 90 juvenile males.

Of the 680 bats sexed from flights, 472 were females and 208 were males. Of the 561 juveniles sexed from the walls, 246 were males and 215 were females, not a significant deviation for a 50:50 ratio ($x_2 = 2.091$). If we may assume that the juveniles of each sex occurred in the flights in equal abundance, the young of the year represented 86.6 per cent of the population in August.

The mortality rate of juveniles is possibly high as compared with that of adults. Of 720 skulls collected at random from the cave floor, 427 were those of juveniles retaining the hooked milk incisors or with incompletely erupted canines, and 293 were those of adults.

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LOCALIZATION OF ACTIVITY IN TWO INDOOR POPULATIONS OF HOUSE MICE, *MUS MUSCULUS*

By Howard Young, Robert L. Strecker, and John T. Emlen, Jr.

The appraisal of distances covered by small mammals in their ordinary foraging excursions provides basic information for planning the efficient distribution of traps and baits in population studies and pest control campaigns. Cruising range and movement data are also useful for testing the applicability of population indices such as the Lincoln Index (Lincoln, 1930) and for studying isolation and local differentiation in natural populations.

The extent of the cruising range of house mice, *Mus musculus*, living as natural infestations in two buildings was investigated as a part of a general population study of this species at Madison, Wisconsin. Data were obtained by individually marking (toe-clipping) mice as they were live-trapped, and noting the location of all subsequent recoveries. A total of 1781 individuals was thus marked between September 28, 1948, and June 14, 1949. Of these, 942 (52 per cent) were recovered one or more times, an average of 1.7 repeats per individual, providing a total of 1572 records of movement. It should be noted that young animals were not adequately sampled, and that the following considerations pertain primarily to adults.

Both populations inhabited essentially the same type of environment, i.e., a heated building with an ample supply of water, food, and cover. The population hereafter designated as "A" inhabited 13,000 square feet of floor space on two floors in a wing of building A; the second population ("B") occupied 4,900 square feet on two floors of a section of building B. Openings for ingress and egress were numerous, especially in A, but other parts of these buildings supported low mouse populations, and there was no evidence of egress. Traps set in surrounding areas and neighboring buildings caught over 500 mice of which only two were marked animals from the study areas. Both of these were within 120 feet of sites of previous capture so are not considered as emigrants.

The areas studied contained racks of cages for rabbits, white mice, white rats, poultry, doves, etc., used in experimental work at the University of Wisconsin. The wild mice under study had easy access to most of these cages, and were thus provided with an abundance of food and water. Shelter for refuge and for nesting was present in abundance in building A, and in slightly less amount in building B. No point in either building was more than ten feet from escape cover.

Population levels were high in both colonies, as indicated by the good trapping success and large total catch. The density was somewhat greater in A than in B. Each population was artificially depressed during four of the eight months by the distribution of a water solution of sodium fluoracetate (1080 rodenticide). The depressing effect of this factor on the populations is the subject of another paper.

Methods.—Mice were caught in wooden box traps, 3 x 3 x 10 inches, baited with peanut butter. Seventy of these were kept in operation in colony A and 35 in colony B, a trap density in A of about one per 186 square feet, and in B of

about one per 140 square feet. The traps were spaced at irregular intervals mainly along the walls where the greatest amount of mouse sign was found and where they would not be disturbed by people. The distance between adjacent traps averaged 13.7 feet in building A and 11.8 feet in building B; it was never less than 5 feet, and no spot in either building was more than 20 feet from a trap. Small shifts of trap location, three or four feet in any direction, were made from time to time as old sites were disturbed or otherwise became unsuitable.

The traps were set three consecutive nights out of each week, being serviced and reset in the morning. Marked mice found dead were assigned for location to the nearest trap. The error so introduced was slight and considered subordinate to the considerable convenience provided by the system.

Various methods have been employed for interpreting livetrapping data and for translating them into terms of individual movement and home range. These methods have recently been reviewed by Hayne (1949), and a further brief discussion of them as they apply to the present study is presented later in this paper. For reasons explained in this discussion, linear measurements have been considered preferable to areal measurements for the problems at hand, and the distance between successive captures has been adopted as the most satisfactory and convenient index of movement.

The measurements here presented would obviously be benefited by statistical analysis. However, an examination of some of the field procedures as described above, viz. the irregular shifting of some of the trap sites and the arbitrary assignment of recovery locality of mice found dead to the site of the nearest trap, show that precise statistical tests are not justified for the absolute measurements. Statistical analyses are, accordingly, used only in comparing data from different segments of the population in places where the data warrant them.

The writers wish to express their grateful acknowledgment to Dr. John C. Neess and Dr. James F. Crow of the Zoology Department for their advice and assistance in the interpretation of the data.

Results.—Mice in the populations under study were strongly localized in their activities (Fig. 1). The greatest distance moved was 140 feet (one individual); the average was 12 feet; 90 per cent of the movements were not more than 30 feet and 70 per cent of the movements were not more than 10 feet. These figures are believed to be indicative of the normal cruising ranges of established animals. Although the trapping areas were 170 feet long in building A and 115 feet long in building B, only six movements of over 100 feet between captures were recorded. The frequency and extent of travel by individuals that are responsible for the establishment of new infestation sites in remote places is a different problem, not considered in this paper.

Various authors have pointed out that the presence of traps near a mouse's center of activity may tend to interfere with its chance of being caught in traps farther away. Such interference would exert a reducing effect on measurements of individual range. In the situation here studied, however, the infrequency of recapture suggests that this factor was of rather minor importance. The probability of a marked mouse being captured on any particular trapping night

when he was present was only 0.054 (unpublished data). The effect of this interference, whatever its significance may be, applies only in absolute measurements

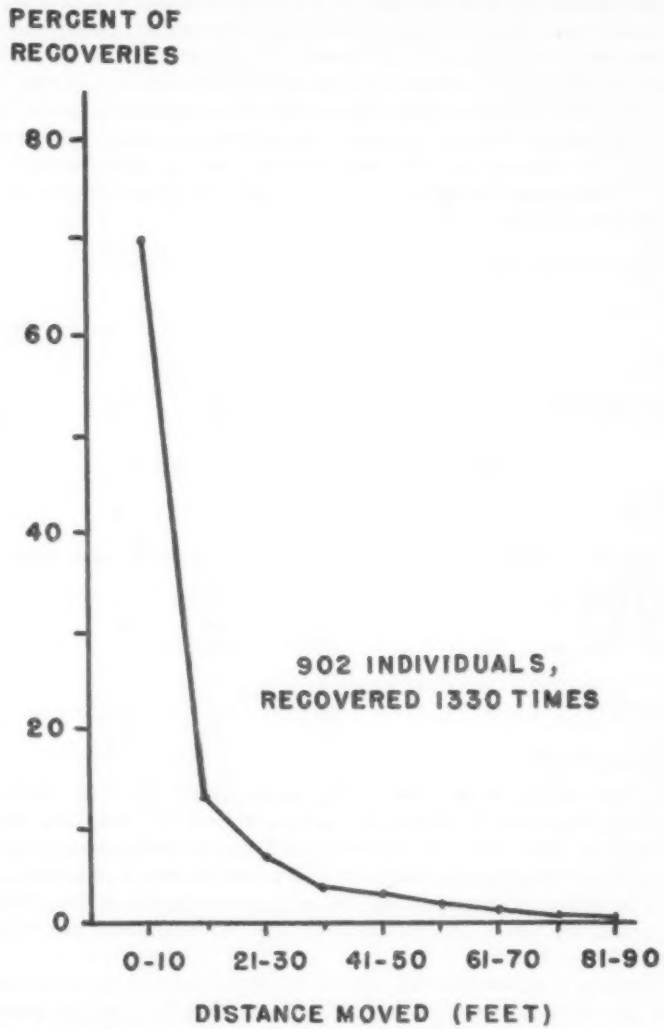

FIG. 1.—Incidence of movements of various magnitudes as revealed by distances between successive capture points.

and need not be considered in relative measurements which compare populations or segments of populations exposed to the same or similar trapping procedures.

The development of habit associations of certain mice for certain traps could also distort average figures by producing large numbers of zero movements. In order to evaluate this possible source of error, the movements of mice recovered five or more times were plotted separately and compared with those which were recovered only once (Table 1, A). The difference between the two groups in the average distance moved between captures is significant by the "t test" (Prob. 0.05), and is indicative of a slight effect which was conspicuous in some individuals. The category of heavy repeaters (comprising 4 per cent of the total) has therefore been omitted from the computations, and all figures quoted in this paper, with the exception of those in Table 1, have been based on mice recovered from one to four times.

TABLE 1.—*A comparison of the extent of movement between consecutive captures of various categories of mice*

	NO. RECOVERIES	MAX. DISTANCE	AVE. DISTANCE	PER CENT UNDER 30 FEET
A: Frequent repeaters vs. single repeaters				
Recovered 5+ times	242	130′	10′	93
Recovered only once	250	130′	12′	91
B: Mice in building A vs. mice in building B				
Building A	934	140′	11′	92
Building B	396	120′	16′	84
C: Mice in populations exposed to vs. those not exposed to poison baits				
Poison (Bldg. A)	383	140′	11′	94
No poison (Bldg. A)	551	130′	11′	91
Poison (Bldg. B)	226	120′	16′	84
No poison (Bldg. B)	170	110′	15′	84
D: Males vs. females				
Males	731	140′	13′	88
Females	599	110′	11′	92

Occasional shifting of individual home ranges within the study areas would exert a distorting effect on movement figures obtained over long time intervals. Analysis of our data shows no tendency for distances between captures to increase with the time interval (Fig. 2). This is interpreted as indicating a high stability of individual range during the eight-month period studied. Such stability permits the elimination of time interval as an important variable in other analyses of these data.

Correlations of movement with habitat conditions were obtained by comparing the data from the two buildings. Mice in building A moved an average of 11 feet between recoveries, while those in building B, where there was a poorer distribution and a smaller quantity of shelter, moved an average of 16 feet (Table 1, B). The difference between the two averages is highly significant (Prob. 0.01) and suggests that smaller individual movements are associated with dense and uniform cover facilities.

It should be noted, however, that buildings A and B also differed with respect to population density and trap density. Information which suggests that population density in itself had little effect on individual movement is provided by comparing movement data in both populations before and after reduction by poisoning (Table 1, C). The slight difference in average distance moved in building B is not significant by the t test (t = 0.54). The actual reduction has not yet been computed, but the extent is roughly indicated by a 14 per cent change in trap success. Unfortunately we know of no means of evaluating the effect of the 9:7 difference in trap density in the two buildings.

A comparison of all measurements for males and females suggests that, as has been commonly noted in movement studies with small mammals, the males are somewhat less localized than the females (Table 1, D).

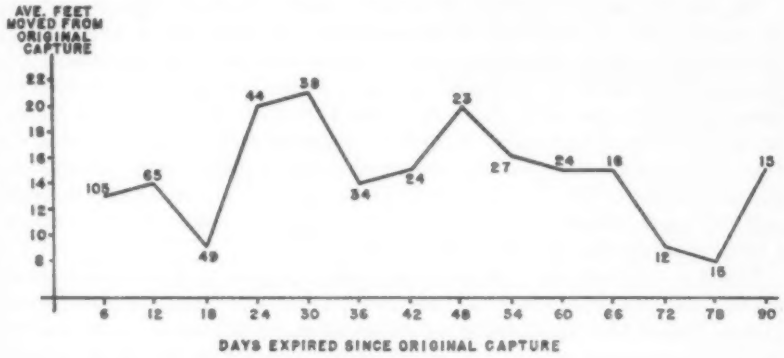

FIG. 2.—Relation of distances moved from original capture point and time interval since original capture. Figures on curve indicate number of observations for each data point.

Discussion.—The characteristic of small mammals to confine their activities to the vicinity of their homes has led to an areal concept of home range. Certain animals, however, tend to establish and follow a relatively simple system of routes and trails rather than spread their activities over broad expanses (Davis *et al.*, 1948: 222). Under such circumstances, at least, linear units seem preferable to areal units for indicating the extent of movement.

Observations of house mice and of their droppings and trails indicate that these animals travel well-defined paths along walls or edges, either horizontal or vertical, and typically fan out from these for foraging only in certain limited areas such as the interiors of feed bins, cupboards, and cages. To comply with these home range characteristics, a linear unit was adopted in the present study as providing the most satisfactory index of extent of movement. Tabulations of linear data, furthermore, can incorporate the intercapture measurements of all mice handled more than once, while meaningful areal determinations can be made only for those individuals that are recaptured a considerable number of

times. In the present study 64 per cent of the repeating animals were recovered only once and 85 per cent were recovered no more than twice.

Any linear measurement derived from trapping data is, of course, no more than an index, and tells nothing of the actual routes followed or total distances traversed. An index of extent of range derived by averaging intercapture distances is, furthermore, not to be construed as either a radius or a diameter of an areal home range. Should the range be circular or spherical, our linear index would be somewhat greater than the radius; lacking any such regularity of form, it is impossible to relate our index with any areal function.

The point of reference used in making linear measurements of individual movements may be (a) the point of original capture, (b) the point of previous (immediately preceding) capture, (c) all points of previous capture, or (d) a mathematically computed center of activity (Hayne, *op. cit.*).

The use of a computed center of activity (method d above) appears to be of particular value in analyzing the characteristics of utilization of home range, but involves a great deal of paper work and seems to hold no advantage over the other methods in the nature of the index figures obtained. The actual relationship between this method and those based on intercapture distances cannot be demonstrated with material secured by trapping on a non-grid pattern. On theoretical grounds, however, the two are related and similar, since intercapture movements which cross the center will tend to balance those which do not cross, and the mean reference point, like Hayne's apparent center of activity, will tend to approach the true center of activity.

The three methods for utilizing intercapture distances to give a range index are basically the same, and, with large series, would give closely similar figures. Indices derived from measurements between all points of capture would provide the greatest amount of data and would produce the largest maximum figures; but these data would not alter or give any increased accuracy to the mean. Measurements between consecutive points of capture (method b above) provide an index which, with large series, is essentially the same as that derived from measurements from the original point of capture (method a above) (Fig. 3). In theory, however, the former is preferable since the exaggerated figures produced by occasional animals originally captured at peripheral stations are not then repeated with recaptures. Reference to the point of immediately preceding capture, furthermore, minimizes the distortion that could be produced by an individual with an unstable or progressively shifting home range, a hypothetical situation which was not encountered in the present study (Fig. 2).

The occurrence of territorial behavior (defense of a habitually occupied area against intruders) has been postulated for several species of small rodents (Burt, 1943). In the house mouse populations under study, however, the infrequency of observed chasing and squealing, and various signs of a highly gregarious society, such as community nests containing many adults and the young of several litters, suggest a weak development or complete absence of individual territorial behavior. The heavy use of established trails and the high overall population densities (over one per twenty square feet in both buildings) also indicate an extensive sharing of space inconsistent with a well-developed terri-

torial behavior. Actual evidence of overlapping ranges is abundant in the trapping data; for example, a total of 172 different mice was caught in the first 25 traps of Colony A during the first two months of the study, an average of seven

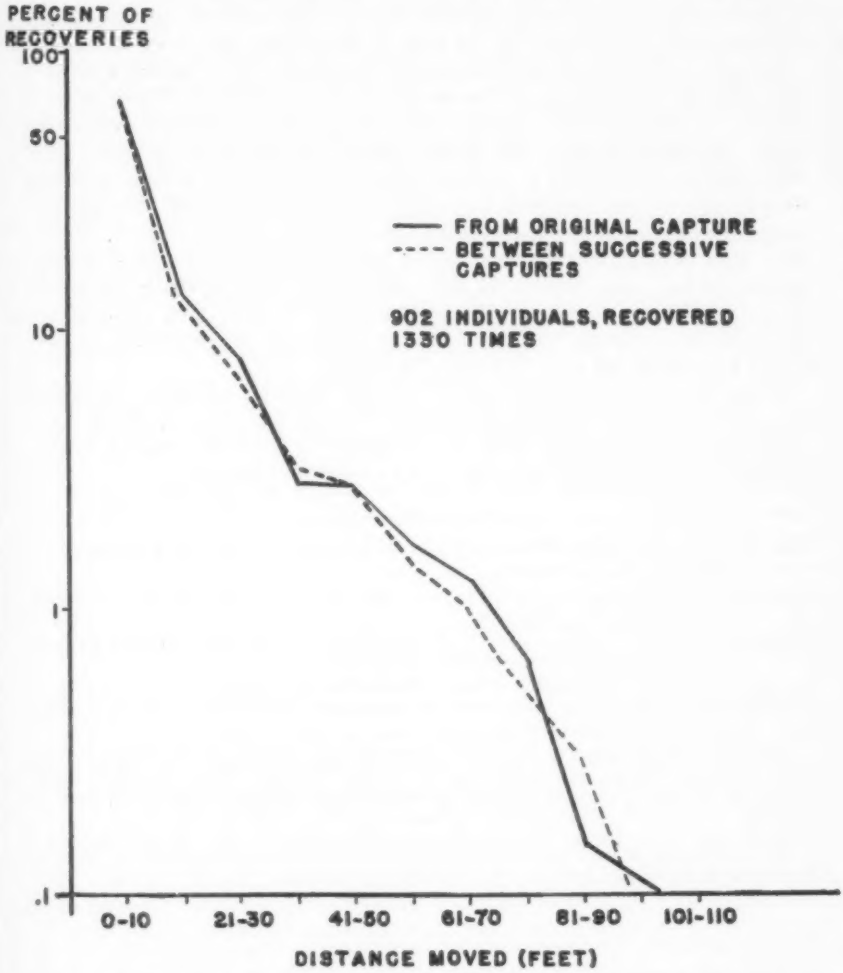

FIG. 3.—Comparison of movement data obtained by (a) measurements between successive points of capture and (b) measurements from the original point of capture.

animals per trap site. These observations do not exclude the possibility of community or group territories.

The extreme localization of activity displayed by the house mice in indoor

habitats in this study suggests the advisability of close spacing of traps or poison baits in population studies or in mouse control work. The non-random movements of individuals in a colony indicates the danger of applying population indices based on repeat capture calculations such as the Lincoln Index. These calculations assume a random distribution of colony members (Evans, 1949), a condition which obviously did not exist in the colonies here under study.

Summary.—Free living house mice studied by repeated live-trapping of marked individuals in two buildings on the campus of the University of Wisconsin were extremely localized in their activity. The average distance moved between captures (1330 measurements) was 12 feet, and 90 per cent of all recoveries were within 30 feet of the point of previous capture. The habitats in these buildings were considered near optimum and egress was apparently slight. Average distances moved did not increase with the time interval between captures, signifying a high stability of individual ranges. Males on an average moved slightly farther (13 feet) than females (11 feet). Mice in the building which had better cover facilities ranged shorter distances (average, 11 feet) than those in the other building (average, 16 feet). Lowering of the population density in each colony by poisons did not affect individual range.

Linear units are considered superior to areal units for indices of individual range in this species. The distance between successive captures is considered a satisfactory and convenient index of movement. Observations indicate a poor development of territorial behavior in the populations studied.

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Department of Zoology, University of Arkansas, Fayetteville, and Department of Zoology, University of Wisconsin, Madison. *Received January 23, 1950.*

FEEDING, CARE, AND HANDLING OF CAPTIVE PORCUPINES (*ERETHIZON*)

By Albert R. Shadle

Many requests for information on the care, housing, and methods of handling porcupines, and several recent suggestions urging an available source of information on these subjects, are the reasons for presenting this paper. The recent growth of scientific and general interest in porcupines is very gratifying and it is hoped that this paper may answer some of the troublesome questions about maintaining these animals. These suggestions, gleaned from laboratory and field experiences with these animals, are offered as aids to those interested in the North American porcupine as a laboratory animal, or as a very interesting and unusual pet (Shadle, 1950).

Acknowledgments.—This work has been partially supported by a grant from the Committee for Research in Problems of Sex, National Research Council. I am indebted to many sources for the procurement of porcupines. Among them are Donald A. Spencer, Dr. H. W. Mossman, Reino Freeman, Allegany State Park Commission, Michigan Department of Conservation, and the U. S. Fish and Wildlife Service. I am also indebted to many students, both past and present, who have aided in the studies on the porcupines. To all I am very grateful.

Requisites for success.—The first requisite to successful handling of porcupines is the proper orientation of the person keeping and handling them. Porcupines *are not* the "dumb, stupid, witless" creatures usually described in the literature, but on the contrary, are rather sensitive animals, therefore, they must be handled and treated with considerable skill, patience, care, and kindness, but with assurance and firmness. If always treated in this manner they may become very gentle and easily handled if you make sure that you always accomplish what you set out to do with the animal. *Never mistreat porcupines!* They remember such experiences sometimes for weeks or months, and it may require considerable time and training to undo the results of one such bad experience.

Porcupine persistence.—In their native surroundings, porcupines may appear to be slow, blundering, foolish animals, when they return time and again to a place from which they have been driven, but there is more than one way to interpret these reactions. When setting out to do a particular thing, or get to a certain place, the porcupine has a dogged persistence and tenacity of purpose which practically insure his accomplishing his project, though it may require many repeated attempts. This trait is evident even in very young porcupines only a few weeks old, for when picked up where they are playing or climbing, and set down ten or fifteen yards away, they will almost immediately turn and go more or less directly back to the place or thing from which they were taken. This may be repeated several times in a short space of time. The same phenomenon has been noted in the partially grown and also in mature animals. They have a considerable tendency in the wild to return repeatedly to the same places, trees, and things.

In a recent letter, Donald A. Spencer, Biologist of the U. S. Fish and Wildlife

Service of Denver, Colorado, has verified for me that he had a case where porcupines had fed eleven successive years at the same spot on a sugar maple limb. The first year, a porcupine gnawed away the bark on the maple limb making the original scar. For the next ten successive years, at least one porcupine fed each year on the living bark around the edges of the previous scar, thereby annually enlarging the scarred area. There is no known way to determine whether the feeding around the edges of the same scar each of these eleven years was the work of one animal or that of several different porcupines. It quite probably involved more than a single animal.

The attempt of the tree to repair the damage often results in producing thicker masses of bark tissue immediately in contact with the wound, and in the sugar maple, this repair tissue is said to store a greater amount of the sweet material. It is this tissue which was taken by the porcupines year after year. The fact that one to, possibly, several different porcupines fed around the same spot on the same tree during eleven successive years is interesting, and it may be significant, but to determine the significance we must have more data.

Containers for catching and transportation.—A very good container for use in catching and transporting porcupines is a 6–8-gallon galvanized garbage can with a bail, which can be pulled up to lock the top on. My cans each has a hole eight inches in diameter cut out of the center of the lid, with $\frac{1}{2}$-inch-mesh hardware cloth soldered over the opening to provide ventilation which is particularly necessary in hot weather. Porcupines are very sensitive to excessive heat, and often show marked signs of distress when overheated in a container, and during very hot weather in the laboratory. In outdoor cages, shade should always be provided so that they can go to it if they feel the need. In hot weather they often sprawl out flat, with legs extended, on the cool floor of their cages. In the woods they frequently drape themselves along a high limb with the legs hanging limply on either side of the bough, as they lie there and sun themselves. Under these conditions the breezes have a cooling effect, and the animals are also free to seek sun or shade as they choose and thus accommodate themselves to any necessary change of temperature.

Donald A. Spencer makes and uses a very clever, heavy woven-wire cone, which has the advantages of being light, strong, and easily transported, and handled in the woods. It also gives a maximum of opportunity to observe and examine the captive animal, as well as to weigh, tag, sex, medicate, etc. I first used it when working with Spencer in the Mesa Verde area and have been much pleased with it in my own work, both in the laboratory and in the field.

A very satisfactory wire cone 28 inches long can be made from a piece of strong woven-wire fence. From the open base 12 inches in diameter, the first 20 inches of the cone taper down to 8 inches in diameter while the remaining 8 inches taper more sharply to 3 inches in diameter at the upper end, which is too small for the porcupine to squeeze through.

When the animal has been driven through the open base of the cone, up into the top, he may be held there and prevented from backing down and out by tightly crisscrossing sticks through the wires behind him. The porcupine can readily be carried any distance in this manner.

Catching and field handling of porcupines.—Porcupines may be found during the day in their dens, or sometimes in the treetops. They are distinctly nocturnal in habit, and that is a good time to hunt them in the woods. They have a habit of following trails, roads, and thoroughfares. If the animal is frightened by a very bright light or a noise, it may immediately bolt up the nearest tree.

When approached very quietly and carefully, or when attracted by imitating their whining call, a porcupine will often approach until it can be caught with little difficulty. To catch the animal, place a wire cone or can over it and fasten the animal in the container. If no container is immediately available he may be captured without it. The thrashing tail is the most dangerous part of the animal, and it may be held down, and the animal secured by a forked stick placed across the tail base. To capture it take a tight grip on the terminal tuft of tail bristles with the thumb and forefinger of one hand and hold firmly to it so that the animal cannot pull away from you as he struggles to free himself. Drop the forked stick and slip the other hand under the distal half of the tail, pushing the quills upward out of the way with the thumb and finger tips, and firmly grasp the heavy tail like a club. Lift the animal up and keep it far enough from your legs and body to be sure it cannot catch hold with its claws or teeth. Once the animal is secured, do not let go until it is safe in a container. Be sure to allow for plenty of ventilation in the container, particularly during the hot weather. The animal can be shipped short distances in a can if the bottom is covered with two or three inches of sawdust, straw, or dried leaves to take up any urine or soft fecal material which may be discharged. This will keep the animal in a cleaner, more comfortable condition in transit.

Shipping.—For short distances of a few hours a single porcupine can be shipped safely in the large garbage can described above for catching. For longer distances, a heavy, fairly tight, wooden box covered with strong wire or half-inch hardware cloth on the top or one side, to allow for ventilation, will be found satisfactory. Water and food should be included for a long trip, particularly if a door is not provided which can be used by the Express Company for feeding in transit (see feeding). The animal should be kept cool, DO NOT EXPOSE TO HOT SUN!!

Laboratory cages.—The laboratory cages for porcupines should be large enough to permit the animals freedom to move about and climb for exercise. Our cages measure 3 feet wide, 6 feet long, and 6 feet high, and give sufficient room for two or three animals per cage. Twenty inches above the floor, a door four feet high across one end of the cage is high enough to permit a person to enter and stand upright while handling the animals. A shelf, eighteen inches wide across the back of the cage, and three and a half feet above the floor, provides a resting place for the animals, and facilitates the handling and examination of them by the operator. The shelf is a frame covered with half-inch-mesh hardware cloth, which permits the fecal material and urine to drop through it into a strong, heavy, 28 gauge galvanized pan which fits into the bottom of the cage and keeps the urine and fecal material off the laboratory floor, thus preventing much of the accumulation of odor by keeping the cement floor clean. These pans contain shavings, or litter, and although they are cleaned daily, they are also thoroughly scrubbed every week.

Care should be taken to prevent the laboratory from being wet and cold, for in captivity these animals readily contract the common cold and even tuberculosis. Once the animals are accustomed to warm laboratory conditions, they readily develop colds when exposed to cold drafts.

Treatment and training in laboratory.—To avoid frightening the new animal and until it is accustomed to the new environment, when it arrives in the laboratory, protect it as much as possible from noises, and handle it as quietly and gently as you can. Imitating the grunts and whines of the purcupine often has a reassuring effect, particularly if done when the animals are hungry and they are offered some acceptable food at the same time. When handled very gently, within three or four days, wild porcupines may begin to associate the imitated whine with the food held out to them. When I approach the animal from behind, whine, and hold a piece of bread near it, the porcupine turns toward me and takes the bread from my hand. Bread is usually rather readily accepted by a new animal in the change to new foods. Talking in low tones may also have a quieting effect. My animals are used to having me talk to them as they are handled, and an individual animal will often respond to its own name, particularly before it is fed. Animals that have recently fed to repletion tend to be relaxed and sleepy. Slight feeding may accompany training, but complete feeding should follow the training and experimentation periods.

Another sound having a reassuring effect on a porcupine is the striking together of one's teeth with the lips held open, which imitates quite well the chattering of the porcupine's teeth. This sound varies greatly in its tone, volume, and meaning, according to the age, size, sex, and the nervous state of the individual animal at the moment. In the young animal a few days old, a porcupette (Shadle, 1950), it is a slight clicking sound which would not be audible except to a person listening very intently, and standing very close to it. When a large male is excited sexually or otherwise, he thrusts his lower jaw forward and rapidly opens and closes his jaws so that the inner or lingual side of his lower incisors strikes against the outer or labial side of the upper incisors, thus making a rapid, sharp, snapping, or chattering sound. This sound is greatly magnified by the forward position of the lower jaw and the animal's open mouth, which seem to increase appreciably the volume and intensity. This chattering of the teeth serves several functions, such as mutual recognition between mother and young, or between two individuals on the trail, an indication of annoyance due to something strange in the environment, the expression of sexual excitement of a male as he approaches the cage, or the presence of a female, and even a state of rage when he senses the presence of a rival male near him. This may drive him into such a fighting temper that the chattering of his teeth reaches its full measure of volume, meaning, and expression. Thus this simple activity and sound may indicate several different reactions.

Using a low moderate chattering of my teeth as a means of communication has caused a newly-arrived wild female porcupine to turn toward me in a rather friendly way when she had made very definite negative responses to my whining sound, for she had struck viciously with her tail whenever approached closely.

In this case the chattering of the teeth brought a more friendly response than the imitation of the porcupine voice.

Feeding.—Porcupines are herbivorous and feed readily on a considerable variety of plants and trees. In the winter, in Eastern United States, particularly in southwestern New York, they depend largely on the leaves and bark of conifers such as hemlocks and various pines, and the bark and twigs of many of the deciduous trees, particularly aspens, elms, and hard maples. From spring to fall, in Allegheny State Park, New York, the leaves, twigs, and some bark of aspens and other poplars, elms, and maples are the staples, although in some regions the evergreens also may be used at this time. Among other things used for food in the laboratory are clover, alfalfa, dandelion, bean plants, violet leaves, apple leaves and fruit, corn, lettuce, carrots, lawn grass, and some aquatic plants. Where these are convenient to the laboratory they should be used. Porcupines are individualistic in their choice of foods. Among things which may be stored and used in the laboratory are apples, carrots, beets, and potatoes. Rolled oats, stale bread, Purina laboratory chow checkers, and dog chow checkers have been standard, well-accepted foods. The rolled oats are a good vehicle for feeding haliver or codliver oil about twice a week.

Nursing porcupines or "porcupettes" can be raised on whole cow's milk with a slight addition of cane sugar, fed for the first few days by bottle with a doll's nursing nipple. They should be fed several times per day, for at first they will take only three to five cc., but in a short time will take as much as 20 cc. per feeding. Later they readily learn to eat bread soaked in milk and some animals will even drink the milk from a pan or dish. In a few days they begin to take a little solid material such as leaves of grass, clover, elm, hollyhock, poplar, etc., and this is to be encouraged. Since young animals continue to nurse in the laboratory until they are three to five months of age, I continue the milk ration with orphans until they are well along in their development or until they refuse milk. If you notice loose bowels or scours, boil the milk before feeding it, or administer a little bismuth subnitrate on a piece of moist bread as a corrective. Scours in the mature animals can also be treated by substituting a brew of tea for the drinking water, and giving slightly moistened stale bread as a vehicle for the bismuth subnitrate which sticks to the moist bread.

Spine removal and treatment.—No paper on handling porcupines would be complete without some mention of the spines, their effects, their removal, and treatment. The nature of the spines and the rate of penetration in human flesh (Shadle, 1947; Shadle and Po-Chedley, 1949) demonstrate the necessity of prompt removal of spines from the body of another animal before they work deeply into the tissues. Judging from my own experience, the pain and discomfort of being "quilled," as it is generally described, seems to me much exaggerated. It is not pleasant, but it also is not the "excrutiating," "burning sensation" often described. The sensations experienced may vary greatly depending on several factors, viz. the number of spines imbedded, the depth of penetration, the location of the area quilled, the degree of sensitivity of the area, the mental attitude and the fortitude of the patient, and many more factors.

My own experiences include slight to sharp pricking sensations, itching, some sensations of warmth, stiffness, and even aching and soreness if the spine has penetrated deeply into a sensitive area like a finger tip. The only treatment we use is to *immediately jerk the quill straight out* with thumb and finger or pliers, making sure not to break off the quill in the flesh, wash the area with 85 per cent alcohol and apply tincture of iodine or merthiolate. Within twenty to thirty minutes, a small area around each puncture becomes slightly inflamed. This slight inflammation and any soreness seldom last longer than 24 to 48 hours. A large number of students, assistants, and I, over a long period of time, have had hundreds, even thousands, of spines penetrate the skin, but I can recall only one case of an infection developing and that was on my own finger and did not amount to anything.

I find quills much less troublesome than splinters, but we have had some definite infections develop in our porcupines and dogs, that have been "quilled."

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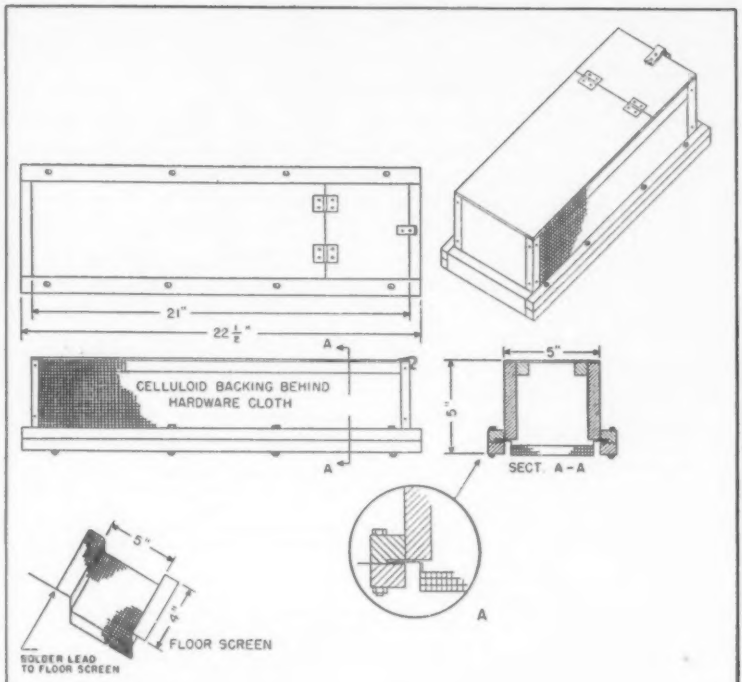
A NEW TYPE OF CAGE FOR RECORDING DAILY ACTIVITY RHYTHMS OF SMALL ANIMALS

BY ESKIL L. KARLSON

In exploring the possibilities of using pellets of radioactive isotopes to follow the activities of animals under natural conditions it was first necessary to determine the effect of such pellets upon the normal activity of animals. As a preliminary step it was decided to check the activity of injected animals against that of control animals by means of activity cages. The popular running drum type cage was first used by Stewart in 1898 to measure running activity. In this cage the rat runs freely inside a rotating drum. Its limitations have been pointed out by Lacy (1945), Skinner (1933), and others. Some of the difficulties encountered were physical variability and low correlation of activity between cages. To overcome these difficulties the cage described below was designed to provide: (1) a high degree of validity and reliability within and between cages; (2) stability in sensitivity to a given controlled range of activity; (3) production of comparable data regardless of fluctuation in the external conditions of the test animal or in the recording apparatus due to humidity, temperature, or line voltage.

Since the activity of an animal in this cage is expressed by its movements along the length of the cage, the dimensions of the cage depend in some degree upon the size of the animal to be tested. The width of the cage should be some-



№	NAME – MATERIAL	DIM.
1	BACK – ½" COMPO BOARD	4"x21"
2	SIDES– " " "	4"x5"
1	TOP – " " "	5"x21"
1	CELLULOID BACKING	4"x21"
1	¼" HARDWARE CLOTH SCREEN	4"x21"
5	" " " "	6¼"x4½"
4	SIDE STRIPS – PINE	¾"x 1" x22"
2	END " "	1"x1½"x5"
4	CORNER STRIPS – PINE	¾"x 1" x 4¼"
2	TOP " "	¾"x 1" x 21"
4	CORNER ANGLES – SHEET STEEL	½"x ½" x 3½"
2	HINGES	

ACTIVITY. CAGE
DRAWN BY: E L. KARLSON
APPROVED BY: C. A. TRYON
DATE: APRIL 5, 1949

FIG. 1.—Activity cage, showing structure.

what greater than the body length of the animal, exclusive of the tail. The length of the cage should be approximately four times its width.

Ten cages measuring 5 inches by 21 inches were constructed for determining

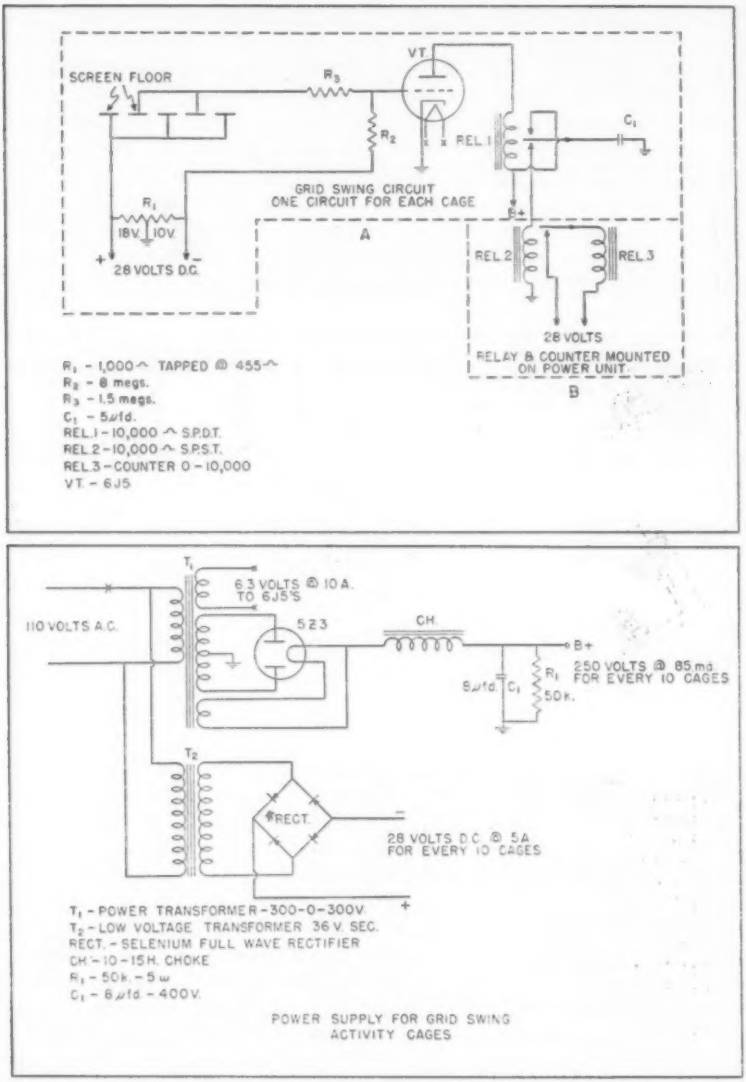


FIG. 2.—Activity cage, showing circuits and power supply for grid swing.

the activity rhythms of mice. The ends, top, and back were made of $\frac{1}{4}$-inch masonite with the smooth surface inside. A wood framework of 1 x $\frac{3}{4}$-inch stripping was used for support. The front of the cage was made from $\frac{1}{4}$-inch hardware

cloth and covered on the inner side with a sheet of clear celluloid to prevent climbing. The bottom, which registered the activity, was made of five 4 x 5-inch plates; each plate was constructed of $\frac{1}{4}$-inch hardware cloth and was separated from its neighboring plates by a $\frac{1}{4}$-inch gap (Fig. 1). The plates were attached to their supporting bars in the manner shown in Figure 1, A, to prevent the urine or other moist material from causing a short circuit.

The actual recording was done by a counter which registered once each time the animal moved from one bottom plate to another. This was accomplished by means of an electronic grid swing circuit as shown in Figure 2, Upper, A. The line current was transformed by a standard 600 volt centertapped power transformer, rectified and filtered to produce 250 volts D.C. at 85 milliamperes. This current was fed through plate relays to the 6J5 tubes. Whenever the grid of one of these tubes was swung from negative to positive its plate relay closed. This charged a 5 Mfd. condenser (C_1). If the grid then became negative, the plate relay was released and the charged condenser was discharged through a second ralay which closed just long enough to move an electric counter.

TABLE 1.—*Critical ratios of differences between means*

MOUSE	CRITICAL RATIO	SIGNIFICANCE
A Cages #1, 2, 3	0.4384	None
B Cages #4, 6, 7	0.5498	"
C Cages #8, 9, 10	2.0272	Slight

A "grid-swing" circuit changes the grids from positive to negative and back by the movements of the animal in the cage. This circuit was simplified by using only one 28 volt D.C. power source obtained from a transformer with a selenium low voltage rectifier. This power source was divided into a 10 volt negative and an 18 volt positive supply by the use of a rotor grounded variable resistor. The rotor was set at 10 volts from the minus side of the 28 volt source. The 10 volt minus side was fed directly to the grid of the 6J5 relay tube through an 8 meg. ohm resistor. First it passed through a 1.5 meg. ohm resistor going to the second and fourth hardware cloth plates in the bottom of the cage. The remaining 18 volt component of the 28 volt source was connected to the first, third, and fifth cage floor plates. When the animal steps on two adjacent plates the grid is swung positive by 8 volts as the 18 volts thus released would cancel the grid minus 10 volts by that amount. As soon as the animal moved entirely onto the next plate, the grid again became 10 volts negative, thus releasing the plate relay (Rel 1 in Figure 2, Upper, A).

The insides of the cages, with the exception of the floor plates, were given three coats of polystyrene coil dope to prevent absorption of moisture. The condensers, the counter operating relays, and the counters were all mounted on the main power chassis, thus permitting easy reading or intermittent recording with a 16 mm. electric single exposure movie camera mounted in front of the panel holding the individual counters.

The cost of material for a set of ten cages and the recording equipment did not exceed $100.00. The extra equipment for making photographic records of the counter cost $50.00, including the electric 16 mm. movie camera with an f3.0 lens. The majority of this material was purchased as war surplus and is still available.

During a period of eleven months the bank of ten cages has been in nearly continuous operation. Although cage counts have run as high as 12,000 per day during this period, there has been little mechanical or electrical failure of the equipment other than that caused by a sticking relay or occasional shorting due to urine-soaked food. The tubes used showed little effect when replaced at the end of the first six months. So far we have satisfactorily recorded activity of deer mice, albino mice, and the marble salamander. In all cases operation was satisfactory.

The cages were checked for validity and reliability by taking activity measurements of mice, chosen for the constancy of their daily activity in three different cages. Each animal was kept in its cage for 15 days, then it was moved to another cage for another 15 days, then to the third cage for the last 15 days. The activity of the first five days was not used in calculating a mean as this time was necessary for the mouse to become familiar with its new habitat. Each set of data from each mouse was checked for significant difference from the mean. Only mouse C had differences which were significant. This was believed to be due to the low total count per day. (see Table 1). The apparatus was checked every other day by a vacuum tube volt meter for constant sensitivity and for short circuits.

Summary.—The described cage has proved to be useful in the measurement of the activity of animals in various fields of research. Numbers of movements, distance traversed, and fluctuations in activity over any desired period of time can all be obtained in a form readily susceptible to suitable statistical control.

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OBSERVATIONS ON THE BEHAVIOR AND BREEDING OF CAPTIVE RICE RATS AND WOODRATS

By C. Brooke Worth

The behavior and breeding of captive cotton rats, *Sigmodon hispidus* Say and Ord, are too well known to require further general comment. Very little seems to have been recorded, however, for either the rice rat or the Florida woodrat (Hamilton, 1943).

During the course of studies on murine typhus fever in Hillsborough County, Florida, 1948 and 1949, the writer had occasion to trap and hold in captivity a number of rice rats and woodrats (*Oryzomys palustris natator* Chapman, and *Neotoma f. floridana* (Ord)). It is the purpose of this paper to summarize a number of observations pertaining to these species.

The studies and observations on which this paper is based were conducted with the support and under the auspices of the International Health Division of The Rockefeller Foundation in co-operation with the Florida State Board of Health.

The animals were trapped either in box traps similar, except for being smaller, to the one described by Richter and Emlen (1945), or in metal "Hav-a-hart" traps, which have ½ in. mesh hardware cloth sides and bottoms. The traps were baited with commercial horse feed, consisting of cracked corn, oats, and chopped alfalfa leaf impregnated with molasses. A slice of carrot, sweet potato, or apple was usually added. A wide variety of habitats was investigated, including all the chief types of terrain in the county.

Rice rats were maintained in specially built containers. These had glass sides set in a wooden frame 24 inches long, 12 inches wide, and 16 inches high. Vertical slots situated midway on the sides permitted the insertion of another pane of glass that divided a container into equal compartments. A removable pressed fiber-board bottom facilitated cleaning. The removable lid was a wooden frame set with one-half-inch-mesh hardware cloth.

Commercial dog chow pellets provided an adequate diet for rice rats. Occasionally carrots were given, but these were treated only casually and did not seem to be essential. A salt spool, hung from the top of the cage on a piece of wire, received occasional attention from the animals. Water was furnished in inverted stoppered bottles provided with drinking tubes.

Quart mason jars were provided as dormitories and nesting sites. Screen wire or hardware cloth was soldered into the metal rims of the jars, and when it was desired to move an animal or clean a container, it was necessary only to screw the lids onto the jars.

Pairs of animals were kept together for two weeks to permit breeding. The glass partition was then put into place to give the female privacy when littering. When the young were weaned, the female was placed in a new cage already occupied by a male, in order to destroy her feeling of territorial ownership and to render her submissive.

Woodrats, being considerably larger, were maintained as a rule in more spacious quarters, although they were able to get along quite well in cages no larger

than the single compartment of a partitioned container. Their diet also consisted of dog chow, but they welcomed raw vegetables and fruits with obvious enthusiasm. No measures for separating males from the females and young during breeding were employed. Half-gallon pickle jars were used as retreats for these animals.

Rice rats.—The rice rat was found to be widely distributed throughout Hillsborough County. It was encountered most commonly near bodies of fresh water or on wet ground, but also in old dry fields some distance from the typical habitat. When caught in a "Hav-a-hart" trap it almost invariably pulled in as many weed stems and leaves as it could reach, making a nest sometimes so dense as to conceal itself entirely from view. Cotton rats did not engage in this maneuver.

The same behavior was manifested in the containers. Cotton rats would drag a few of the wood chips that were used as bedding into their jars and proceed to lie on them. The rice rat took in large numbers of chips and shredded each one until it had a nest that resembled a mass of excelsior. This nest completely enclosed the rat, except for a narrow entrance hole.

Rice rats were strictly nocturnal. Whereas cotton rats were more active at night than in the daytime, they would come out to forage or exercise briefly at all hours, and became fully active in the late afternoon. The rice rats, however, were rarely seen in daylight hours unless disturbed. Furthermore, rice rats were solitary. They would not share a nest. No matter how long a male and female were kept together, or how intimate they became, as evidenced by subsequent parturition, they never occupied the same jar together. Almost all mated pairs of cotton rats spent the day cosily side by side in one jar, even if it meant a tight squeeze.

When a female rice rat was introduced into a container occupied by a male, she would first seek shelter. Since the clean jar provided for her was empty, she would enter the male's jar, which already contained a nest. This resulted in a crisis as the male attempted to drive her out or succeeded in doing it. The animals would give a series of excited high-pitched squeaks, biting each other and scuffling in the nest. If the female refused to move out, they would often come to rest in attitudes of suspended animosity, only to resume scuffling and squeaking a short time later. If the female did retreat, she would roam about the container, in all likelihood inspect her clean jar, but not accept it. Eventually she would climb to the hardware cloth lid of the container and run about the wire in an upside-down position, apparently looking for a means of escape. She might spend the rest of the day doing this, but whatever her strategy, by the following morning she would have constructed her own nest. There would be a nest with a concealed rat in each jar.

Copulation of rice rats was not observed. This is in strong contrast to the behavior of cotton rats which often mate almost instantaneously on being placed together. When the female happens to be receptive, cotton rats have been seen to copulate a dozen times within fifteen minutes under such circumstances.

Owing to the seclusion conferred on rice rats by their nests, it was difficult to know when the litters were born. Records as early as February 15 and as

late as October 7 represent the extremes of the breeding season as observed in these captive animals. The possibility that mothers ate their newborn young may account for the failure of litters to appear during November, December, and January. Only one case of such cannibalism was actually observed, but the fact that over half of the couples produced no detected progeny may mean that this practice was a common one. On the other hand the behavior of males and females toward each other was so antagonistic that it seemed remarkable that any successful matings occurred. Perhaps most of the barren episodes meant that copulation had not taken place at all.

Two to four young constituted the litters in this group of animals. The mothers were attentive to their young; they washed them with great frequency. The young were usually not seen until they were several days old, but the solicitude of the mothers when observation became possible casts another doubt on the possibility that newborn young were being eaten. As the young became older, they came out of the jars for short periods during the day and played about in the container. At the approach of an observer they would freeze into immobility. Although they are said to become weaned when eleven days old (Svihla, 1932), some were observed still nursing at the age of twenty days. This could have been due to the artificial conditions which kept them in close contact with their mothers beyond the time when they should have broken home ties. The mothers did not resent the presence of their grown offspring. One female became pregnant by her son.

Rice rats were bred to the fourth generation. No essential change in behavior was apparent in the last progeny except for a slightly less retiring attitude.

This species was cleaner than cotton rats maintained under identical conditions. The cotton rat was prone to spill water from the drinking bottle until the wood chips and fecal collections became sodden. Rice rat containers usually remained dry and sweet.

Woodrats.—Woodrats were found to have a spotty distribution in Hillsborough County. They were taken only in small numbers, invariably in association with large timber and usually in the vicinity of water. Field observations were inadequate for reaching a conclusion as to whether they live in colonies. One group of rats was taken in a garage that was built at the edge of an oak wood. The owner said that he had been troubled by their destructive activities in the garage for a long time.

The behavior of woodrats in their containers was extremely variable. Some rats used the pickle jars as dormitories, just as intended by the writer. Others, however, used them as storehouses for dog chow pellets, filling the jars completely if enough pellets were provided. Still other rats used the jars as latrines, urinating and defecating in the jars and nowhere else. Rats which did not use jars as latrines had a certain part of their cages designated for that purpose, however. These traits of behavior were peculiar to, and constant for, individual rats.

Woodrats, given cages in quiet situations, spent most of the day asleep. They curled up on their sides, sometimes partially twisted so that their heads were inverted. They slept soundly, judging by the fact that an ordinary approach to

the cage often failed to awaken them. If the cage was touched, they would spring up immediately. If several rats were in the same or in adjacent containers, an awakened rat would arouse the others by stamping or thumping one of its hind feet, but never both feet together. As more rats awoke, they too would begin to thump.

The rats soon adopted the containers as their new homes. Several times cage doors were inadvertently left open overnight, and the rats roamed freely about the laboratory or animal building effecting minor damage such as chewing the tags off various cages. But in the morning they were usually back in their containers; if not, they could easily be found hiding near-by, for they showed no tendency to try to escape from the immediate vicinity.

They were easily handled. Our animal keepers wore thick leather gloves for handling all species of rats, but it was scarcely necessary in the case of woodrats, for these animals did not attempt to bite. In one instance a large male, sound asleep at midday, was startled by the sudden opening of its cage door; it leapt up and sank its teeth deeply into the keeper's thumb. This was the only instance of its kind, and even that particular animal never repeated such behavior. Apparently it had bitten before it was aware of the nature of the intrusion.

The usual behavior of woodrats when disturbed in their cages was a combination of caution and inquisitiveness. They would advance as far as they dared, peering at the individual and vibrating their whiskers, then dart into a corner or a jar, only to emerge and repeat the investigation. When food was being put into the containers, or the containers were being cleaned, it was unnecessary to use caution with regard to animals escaping, for they made no move to dart out. When offered a piece of apple or carrot, most of them would advance to take it from the keeper's hand.

It was not originally intended to establish a breeding colony of woodrats, for which reason they were put into unpartitioned cages in random fashion. Fighting was infrequent, only occasionally an animal in a crowded cage suffered injury. When young rats unexpectedly appeared, no rearrangement of the animals was made, but to our astonishment everything continued to go along in serene fashion. Males, females, and young in any numerical combination were kept together successfully. This lends support to Harper's evidence that woodrats are colonial in nature (1927).

Litters varied from one to four animals, with two and three the more frequent numbers. The young at birth were sparsely haired and had their eyes closed. Their skin was almost black, giving them a less naked appearance than is usual among newborn rats. They almost immediately attached themselves to their mother's teats, which are four in number and confined to the inguinal region. Once so anchored, they rarely released their hold, not even if the mother ran roughly over various objects in the container or climbed up the hardware cloth sides. The females seemed to have no regard for the bumpings thus inflicted on the young ones. Occasionally when a mother sprang up from a resting position, one of the young ones would be left behind. The parent would then appear to have no instinct for retrieving it, either in her mouth, which is the usual form of transport by maternal rats, or by any other means; she merely seemed obliv-

ious of the situation. Apparently the baby rat had to depend on the chance that would ultimately bring its mother back to the same spot, when it could reattach itself to her teat.

As the young rats became older they began to roam about the cages independently. But at the approach of a human being, they would rush to their mother, grasp a teat in their mouths, and close their eyes tightly. If the observer stood still, the young would open their eyes slightly, but seeing the intruder still there, would press them shut again.

The writer believes that this "apron string" behavior continued past weaning. It is possibly a means for the female to carry her young to a place of safety during an emergency in nature. Or else it represents abnormally prolonged suckling due to confinement.

Breeding schedules for woodrats were not kept, but it was observed that young animals were produced most abundantly during the warm months. At times there would be long gaps between the litters of a given female, but occasionally she would have a new baby while her previous ones were still hanging to her teats. In such cases she would usually have only a single new offspring.

Discussion.—The chief purpose of maintaining rice rats and woodrats in captivity, outside of typhus investigations, was to determine whether these animals, like the cotton rat, might be suitable laboratory animals for general experimental use. The foregoing remarks make it clear that rice rats are distinctly not adaptable to such employment. Not only is their solitary habit a serious drawback, but the irregularity of their breeding, with failure to mate, sterile matings, or maternal cannibalism of litters, points up the impracticability of manipulating rice rats on a large scale in the laboratory.

Woodrats give much more promise of being useful. They may be kept together in numbers and they are gentle and clean. The chief disadvantage in this species is that it is not sufficiently prolific. It cannot be said that the woodrat does not multiply rapidly, but in a relative sense, compared with cotton rats or with commensal laboratory rats and mice, it lags behind.

It is a cause for some wonder that the woodrat is not more abundant in Hillsborough County, since the rate of reproduction, prolonged maternal care, and mutual tolerance among adults would seem to favor the development of large colonies of these animals. Possibly habitat limitations lead to more competition in nature than one would suspect after viewing our placid cage colonies. Or perhaps natural enemies take a severe toll of these easy-going rats.

Summary and conclusions.—Captive rice rats make nests of shredded shavings in which they completely conceal themselves. They are nocturnal and solitary.

Rice rats were bred to the fourth generation in the laboratory. Littering was highly irregular; it could not be determined whether: (1) mating had failed to take place; (2) mating had been sterile; or (3) the females had eaten their newborn litters.

The rice rat is not suitable as an all-purpose laboratory animal.

Captive Florida woodrats are clean and docile. Males, females, and young may be kept together successfully.

Littering is somewhat irregular in woodrats, and the rate of reproduction is

relatively low. The young grasp their mother's teats and are thus transported from place to place.

Except for its slow reproductive rate, the woodrat is adaptable to general laboratory use.

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RELATION OF MOON PHASES TO THE OCCURRENCE OF MULE DEER AT A WASHINGTON SALT LICK

BY IRVEN O. BUSS AND FRANK H. HARBERT

General observations of mule deer were made from 12 July to 10 September, 1948, at Table Rock Lookout, the highest point in the Blue Mountains of southeastern Washington. Counts of deer were made for 34 days to show the relation between numbers of deer on the area and the lunar phases.

Table Rock is a flat-topped mountain having the appearance of a reasonably symmetrical peak with a truncated apex. With an elevation of 6300 feet, it commands an excellent view of the headwaters of the Wenaha River, the Touchet River, and Mill Creek. The lookout house from which all observations were made is situated at the western edge of the "table top" overlooking the Mill Creek watershed.

The salt-lick area on which the deer were observed starts about 20 feet east of the lookout house, covers approximately five hundred square feet, and has many choice licking sites within its boundary. Deer were "salted" here by the state game department in previous years, and former occupants of the lookout have dumped hundreds of pounds of salt on their own initiative. These two sources of salt, plus dishwater thrown on the same spot for many years, have built up an extremely popular lick in a region where natural licks are scarce. In fact, the deer utilize this lick to such a degree that the Forest Service has issued orders to refrain from further salting because the deer now constitute a nuisance. Feeding activities and trampling loosened all the soil which was eaten by the deer or which was blown away, so that the area east of the lookout house has been reduced to a jumble of rock.

General observations.—The lick area was utilized by deer every day of the observation period, but with great variation in numbers. Only deer used the area

during this period, but a cow elk that attempted to use the lick was either discouraged by the semi-hostile behavior of the deer or by the presence of humans.

As watching continued certain individuals could be recognized by prominent scars, ear tears, and antler peculiarities or malformations. All deer seen were in

TABLE 1.—*Daily count of mule deer on salt-lick area*

1948 DATE	BUCKS	DOES	SPIKE BUCKS	UNIDENTIFIED DEER*	TOTAL
July 15	4	9	3	2	18
" 16	5	10	3	1	19
" 17	7	8	1	2	18
" 18	7	11	3	4	25
" 19	8	12	5	2	27
" 20	9	17	2	1	29
" 21	8	14	2	1	25
" 22	7	15	2	2	26
" 23	10	15	1	1	27
" 24	7	14	4	2	27
" 25	10	14	3	1	28
" 26	7	14	1	0	24
" 27	9	14	2	1	26
" 28	7	12	3	1	23
" 29	8	11	2	1	22
" 30	9	12	1	0	22
" 31	8	11	2	0	21
Aug. 1	6	10	2	1	19
" 2	7	9	3	0	19
" 3	6	8	1	0	15
" 4	3	6	2	0	11
" 5	3	5	1	0	9
" 6	2	6	2	1	11
" 7	2	5	1	0	8
" 8	4	7	1	0	12
" 9	4	6	2	0	12
" 10	4	7	1	1	13
" 11	5	9	2	1	17
" 12	6	10	2	1	19
" 13	7	12	3	1	23
" 14	9	11	2	2	24
" 15	7	12	2	1	22
" 16	8	13	3	0	24
" 17	8	14	2	0	24
Totals	221	365	72	31	689

* Small animals showing no antler development or other discernible sex characters.

the red coat except three that remained gray through the summer—one buck and two does that were habitual visitors. The buck was probably old, having very large-beamed antlers with only three points on one side and four on the other. Both does and bucks displayed numerous scars on face, head, and rump. Unper-

forated or untorn ears were the exception rather than the rule except in spike bucks and apparently yearling does. The district forest ranger pointed out that some fawns are caught and earmarked by ranchers through personal interest and curiosity. This probably accounted for some of the more striking angular tears in ears.

The time of arrival at the salt-lick area was almost constant on clear or partly cloudy days, but during rainy periods deer arrived earlier or stayed away from the area. Three does stayed on or close to the area throughout the day and did not wander far beyond the boundary for three and four days at a time. These

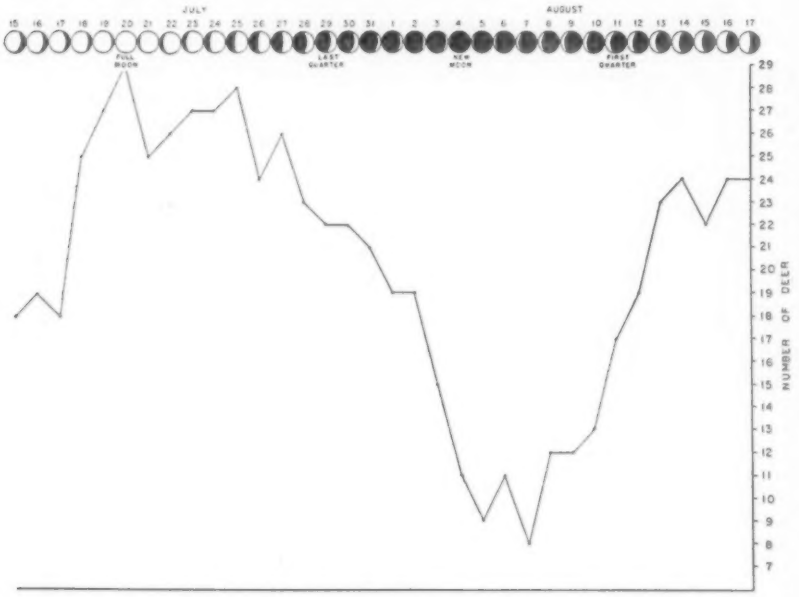

FIG. 1.—Phases of the moon and occurrences of deer at a salt lick.

does rested in the shade of the lookout house or the flag-pole base from 10:00 in the morning until 4:00 in the afternoon. Other does and spike bucks began to appear at about 4:00 in the afternoon and continued to come and go throughout the night. The fully developed bucks usually reached the lick area between 6:00 and 7:00 in the evening, which was well after most does and spikes arrived. These older bucks seemed to maintain definite groups while feeding on salt. All animals which were recognized seemed to approach from the same direction each day. Does did not travel frequently up open ridges, but remained in cover, probably to hide their fawns. During the entire summer no fawns were seen on or near the salt-lick area. Three distinct groups of large bucks were observed using the same trails consistently during their ascent from the Mill Creek watershed.

Behavior on the area.—Behavior on the salt-lick area, especially among does, appeared similar to the peck order in birds. Individuals seemed to have a definite priority on choice licking sites, and all does contested and defended their particular places against bucks, that were driven away in most cases. Very little conflict occurred among the larger bucks; only two fights were observed. Both times sparring was confined to rearing and "chopping" with front hooves in the same manner as does. These skirmishes were short, and the bucks seemed to be careful to protect their undeveloped antlers. Spike bucks were forced to accept sites that the rest of the group did not prefer. Skirmishes were frequent between spike bucks and does, and they dominated the younger males, driving them to the edge of the salt-lick area.

The deer generally showed little fear of man or dogs. The does remaining during the day seemed openly belligerent toward dogs, and in one case a small mongrel belonging to a visitor was severely cut and trampled. Wariness and distrust were more pronounced in the mature bucks. Does generally paid little or no attention to human movements about the lookout house. The animals seemed to be more concerned with strange objects and movements than with humans to whom they were accustomed. Flapping of the flag by a sudden gust of wind would scatter deer in all directions, but the discharge of firearms caused the deer merely to jump or start, but not run.

Deer occurrence in relation to lunar phases.—Counts of all deer (689) on the salt-lick area were made at 7:00 in the evening each day from July 15 to August 17. The composition and total number of deer counted daily are shown in Table 1. The total counts shown in the table have been plotted and are compared graphically with the phases of the moon in Figure 1. The figure shows a striking correlation between the period of bright moonlight and the occurrence of deer. On the evening of July 20, when the moon was nearly full, 29 deer were counted. This was the largest number obtained. As the moon waned the frequency of deer occurrences declined. On August 7, two and a half days after new moon, only seven deer were counted. With the approach of the first quarter, the frequency occurrence of deer started to rise. By August 17, about five days after the first quarter, the occurrence of deer had risen to 24. These data point to the conclusion that deer change the time of their feeding activities which are correlated with changes in the moon.

State College of Washington, Pullman, Washington. Received April 22, 1950.

NOTES ON THE MALAY TAPIR AND OTHER GAME ANIMALS IN SIAM

By Colin Campbell Sanborn and A. Rush Watkins

When the Rush Watkins Zoological Expedition to Siam was planned by the Chicago Natural History Museum it was found that little information was available on game, methods of hunting, availability of guides and life histories of animals, especially the Malay tapir. The notes accumulated by the Rush Watkins Expedition are published here as an aid to others who may visit Siam.

There is no agency for organizing hunts for sportsmen and one must rely on local information about hunting areas. Game is fairly plentiful, but experienced hunters and trackers were scarce in the areas visited by the Expedition. Most shooting is done from machons (platforms usually built in trees and high enough to be out of reach of elephants) over water holes or, if hunting for tiger or leopard, over live bait. The best hunting is said to be the dry season from January to April. While a prolonged dry season in 1949 was a benefit to the Expedition, the vegetation has become so high and dense by July and August that animals could easily evade the hunters.

Travel in Siam is by train or boat, and in some places by truck. Baggage may be transported to some hunting grounds by water-buffalo cart, but in most places good game country can be reached only on foot with coolies, who are not always easy to hire.

While the cost of living and wages are moderate, from $800.00 to $1,000.00 a month should be allowed for two men, traveling with ten to fifteen pieces of baggage, on a hunting trip. The language is not easy to learn, and in the south of Peninsular Siam, Malay is spoken, so the service of one or two interpreters becomes essential. Interpreters receive from $75.00 to $125.00 a month.

Official letters from Government officers were of great help, and provincial governors, police chiefs, and judges were extremely helpful to the Expedition in many ways. In the north Messrs. Ken and Jim Gairdner of Wang Pratart Farm were hosts to the Expedition. In the south the hunting arrangements were handled by Mr. Man Lilabhan of Nakorn Sritamarat, a business man, hunter, and animal dealer familiar with the region.

The Expedition spent three weeks, from June 16 to July 4, in Kam Pang Pet Province on the Klong (River) Klung near the Me Wong Valley in west central Siam. Another period, from August 1 to 23, was spent in Setul Province in southwest Peninsular Siam. In the Klong Klung region there are low hills covered with dense evergreen forest while the upper reaches of the Klong contain extensive areas of high elephant grass. Setul Province is a region of rice fields, rubber plantations, and open swampy grass land, with stretches of heavy jungle scattered along streams and on low hills, while the whole area is surrounded by steep-sided and heavily-forested limestone hills.

A small herd of Eld's deer (*Rucervus eldii platyceros* Gray) was found at the Gairdner's rice plantation, Wang Pratart Farm, on the Me Ping River about fifty miles from Pak Nam Pho and ten from Kam Pang Pet. The Expedition

secured one old buck and a yearling buck and saw evidences of seven or eight other individuals. More are seen in the dry season from January to April when they come into the rice fields. Mr. Jim Gairdner had a pet buck for a number of years and said that July 11 was as late as it kept its antlers. The old buck secured by the Expedition on July 14 had only very recently dropped its antlers. Mr. Gairdner presented the Expedition with three very fine pairs of antlers. The young Eld's deer are born about October. In summer the coat is red with white spots and in the hot season, winter, it is gray. In the opinion of local hunters the animal will be extinct in Siam in the next four or five years. Like Schomburgk's deer, it is an open country animal and the extension of the rice plantations with settling of the country and more shooting is slowly exterminating it.

Sambhar were reported as fairly common on the Klong Klung. Barking deer were said to be common near Setul and a dozen or so skins, the results of the two month's hunting, were seen in a Malay village. Pigs were fairly common everywhere, but especially in the south.

Tiger signs were plentiful everywhere. A "machon" was built on the Klong Klung and the junior author sat up for one night; two tigers stayed hidden in the elephant grass near by all night, and no other game appeared. Tigers were twice reported stalking cattle during the day and an unsuccessful drive was made for one. The abundance of pig probably accounts for the number of tiger in the south.

The wild elephant, the only animal at present protected in Siam, is plentiful along the Klong Klung. Tracks and signs were abundant and elephants often raided the small fields of sweet corn grown near the jungle settlements.

The Malay tapir occurs in Siam from at least as far north as Kam Pang Pet Province south through Peninsular Siam. The Siamese name is P'som-sett, which means a mixture; folklore says that after all the animals were made the Creator took everything that was left over and made the tapir!

The Expedition saw no young tapirs, but partly grown young still with their mothers were reported in both sections of the country visited. From information given us by hunters it was estimated that the young were born in November or December. Whether the tapir breeds every year or every other year was not definitely ascertained, but from the large size of young still with the mothers it seems probable that it is every other year.

The junior author spent many hours and days with the hunters trailing tapir, and found that it follows a zig-zag course during its nocturnal feeding, taking a few leaves from one bush and then moving on to another. It appears to keep moving, never staying long in one spot and never eating all the leaves on a bush. In the north they were feeding on an unidentified thorny bush and on four kinds of bushes in the south. During their feeding they often leave the jungle to cross open areas. We were warned against general shooting around camp that would frighten away the tapir.

In hunting tapir it is desirable to have a light camp, easily moved, as when the animals are shot at or driven they are said to change their grounds, usually going towards the forested hills. The authors found this to be the case.

Before the tapir beds down for its daily rest in some thick jungle it makes a hairpin turn down wind from its trail. If driven from its bed ground it invariably back tracks on its trail when escaping. Knowledge of this fact is the secret of successful tapir hunting. Combined with this information, however, must be the services of an expert tracker who knows the area being hunted and something of the general habits of tapir. The Expedition found but one man who was a good tracker. He had a projection at the base of one thumb which had earned him the name of Eleven-fingers. He had two other hunters who worked with him, but he was by far the best tracker and knew most about the habits of tapir.

When the hunters found very fresh tracks entering a piece of jungle they circled it to discover if the animal had gone on through or was still inside. If no tracks were found leading out the gunners were posted on and near the entering trail and the animal then driven out. On the first drive the tapir charged out into a group of three hunters and stopped on seeing them. After this specimen was taken a second drive for another animal brought the tapir out at a gallop between two hunters. Another drive was through dense jungle for a female with a partly grown young. These two animals were driven twice in one afternoon, and each time the female separated from the young one and came close enough to the hunters for them to hear her crashing about in the undergrowth; but on each occasion she turned back, either because she scented the hunters, or to rejoin her offspring.

The Expedition secured two tapir, both males, one fully adult and one with the last molar just erupting. The first was killed with a 30–06 rifle and the second was shot on the run with a rifled slug from a 20-gauge shotgun. Although the slug passed near the heart the animal ran nearly 500 feet before dropping. It was estimated that each one weighed between seven and eight hundred pounds.

Tapir skins are notably difficult to preserve and in the hot and humid climate of southern Siam special precautions were taken. The animals were at once washed with a solution of four ounces carbolic acid to one gallon of water. A platform of saplings was made on the ground and the animal dragged up on it to allow a little circulation of air under it. As the skin was removed it was washed with the carbolic acid solution and salt rubbed into it. The skin on the back of the head and neck is nearly an inch thick, so that it cannot be skinned over the head. The skull has to be taken out through a cut on the back of the neck. The Brazilian tapir, with the jaguar and puma to contend with, does not have so thick a skin. The Malay tapir is preyed on by the leopard and tiger.

Removing the skin kept four men hard at work for two and a half to three hours. In camp another three hours was spent by the four turning the ears inside out, splitting the skin around the eyes, opening and cleaning the lips and proboscis, and skinning the feet down to the base of the toes. The skin was then salted and rolled up until the next morning. It required five more hours to shave the skin down with a beaming knife to permit a better penetration of salt. After being salted twice and rolled up for two days it was hung in the shade to dry, but had to be taken down each night and during rain storms and placed in a canvas bag.

The total of seventeen tapir was recorded during three months in Siam. In the south the expedition collected two; a female accompanied by a male was shot by a Malay, but the skin spoiled before we could be notified; a male was captured in a pit by some Malays; two females with partly grown young were heard or their tracks seen. These nine animals were in an area roughly twenty miles long by five miles wide. Tracks of two or perhaps three tapir were seen in the north and a female with half grown young was reported. Before the arrival of the Expedition in Siam a young one was found in a deep hole near Petchauburi, and two were captured by wild animal dealers near Hua Hyn. Tapirs were most plentiful in the south, perhaps because the Malays associate them with the pig and will not touch them. It is not hunted in northern Siam and those killed are either shot for sport or through ignorance of what the animal is. The animal dealers get some young ones every year and the mother is sometimes killed in order to capture the young.

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DETERMINING FECUNDITY IN MALE SMALL MAMMALS

By E. W. Jameson, Jr.

In many of our wild rodents and insectivores the breeding seasons differ greatly from place to place and season to season. Because large series of females are not always available to the field naturalist, it is useful to know the breeding condition of both sexes.

In early life history accounts fecundity of males was judged from the position and size of the testes, usually denoted in such terms as "large" or "small." The size of the testes may well afford a precise criterion of fecundity, but the critical length doubtless varies among the different species. Position of the testes, whether "scrotal" or "abdominal," is sometimes extremely difficult to judge, and of limited usefulness; and it is the experience of those who have handled live rodents (*Peromyscus*, at least) that the testes may readily be shifted in position more than once a day. Actually, a scrotum does not exist in *Peromyscus:* in the breeding condition the testes of deer mice lie in a cremaster sac, a shallow depression in the abdominal cavity, contiguous with the abdominal cavity for virtually the entire length of the testes. Indeed, it appears that this position is constant, regardless of the breeding condition of the animal or the season of the year.

Present day standards of research demand a fairly high degree of accuracy. A recent article by Christian (1950) offers a means of establishing fecundity in male small mammals, but requires a stained smear of a testis and a caput epididymis. Sometimes field conditions make such preparations rather difficult and impracticable.

In post-mortem examinations of males fecundity is necessarily judged from the appearance of the genital structures. Regardless of what method is used, unless breeding tests can be made, the reproductive ability of males can only

be inferred: that is, no evidence such as the presence of embryos is available. Presence of sperm, then, is frequently taken as indicative of fecundity, even though the physiological condition of the sperm cannot be established.

The size of the tubules of the cauda epididymes, whether or not they are clearly visible macroscopically, has been used as one criterion of fecundity in males of *Microtus* (Hamilton, 1941: 4; Jameson, 1947: 144). When the tubules are so swollen as to be clearly visible to the naked eye, they seem always to contain

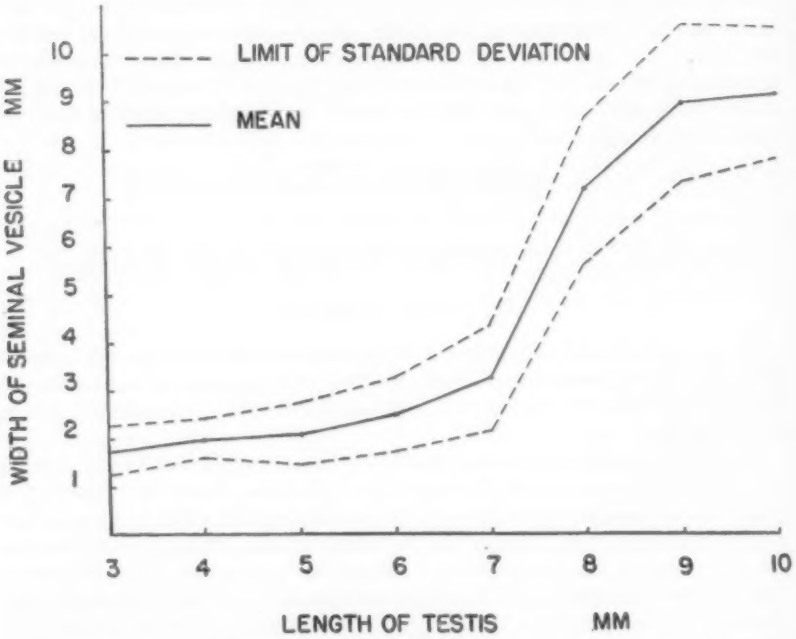

FIG. 1.—Correlation of the development of the seminal vesicles and testes in *Peromyscus maniculatus*, based on 249 specimens from the northern Sierra Nevada of California and including no specimens in which the reproductive structures were regressing.

sperm; but when they cannot be discerned, they are void of sperm. Intermediate conditions, when the tubules are just beginning to enlarge, indicate the presence of few sperm. This intermediate condition is scarce, suggesting that there is a rapid change from the non-reproductive to the reproductive condition. Perry (1945: 24) similarly found that most individuals (of *Rattus norvegicus*) had the cauda epididymes with either no sperm or many sperm; specimens in which the cauda epididymes contained "few" sperm were relatively uncommon.

In determining the reproductive condition of *Peromyscus maniculatus* in the northern Sierra Nevada, near Quincy, Plumas County, California, I have been

guided by the appearance of the cauda epididymes and the development of the seminal vesicles and prostate as well as the size of the testes. Growth of the testes becomes evident in late winter as the first indication of sexual awakening. At that time they increase from the non-fecund length of 2 or 3 mm. to 10 or 12 mm., and the animal becomes ready to breed. Accurate measurements of testes and seminal vesicles can be made with the aid of an ocular micrometer in a dissection microscope. When the testes are between 7 and 8 mm. long, the seminal vesicles (with their associated prostate) suddenly enlarge (Fig. 1), spread out latero-ventrad, develop rounded lobes, and become quite turgid. The length of the seminal vesicles was measured on a line extending from the site of origin (or midpoint of the animal) to the lateral tip, perpendicular to the longitudinal axis of the animal's body. This distance is variable because the lobes vary slightly in their position. The rapid and considerable increase in their length, however, makes these errors negligible. A similar correlation of the development of the seminal vesicles and prostate with the testes has been demonstrated by Rowlands (1936: 116) for *Clethrionomys glareolus*. He stated, "It is apparent, therefore, that the growth of the seminal vesicles and prostate relative to that of the testes at the onset of the breeding season exhibits a marked lag, and does not, in fact, begin until the testes have attained a comparatively large size and considerably after the stage at which mature spermatazoa are found in both the testes and epididymes." At about the stage at which the seminal vesicles and prostate begin to enlarge, the cauda epididymes become clearly visible macroscopically as masses of swollen tubules. Microscopic examination of smears made from these tubules revealed that they contained large quantities of sperm. In *Peromyscus maniculatus* these changes occur at a testis length of 7.9 to 8.1 mm.; the tubules become conspicuous when the seminal vesicles measure about 6 mm. In occasional individuals the tubules alone suggested fecundity before the seminal vesicles and prostate had begun their rapid growth; but such specimens were considered non-fecund.

In late summer and fall many specimens are captured when their reproductive structures are regressing. Such male specimens are easily recognized by their olive-colored, flaccid, and more slender testes. These individuals are apparently not fecund. Although the testes may be more than 8 mm. long, the reproductive structures no longer have a conspicuous vascular supply, the tubules of the cauda epididymes do not contain sperm, and the associated accessory structures are shrinking and flaccid.

The correlated development of the seminal vesicles, prostate, testes, and cauda epididymes thus seems to provide a reliable field method for determining fecundity in males of *Peromyscus maniculatus;* and the same situation doubtless obtains in many other genera of small mammals. The development of the seminal vesicles and prostate is so rapid that in most animals these structures are either minute (2 mm. or less) or well developed (7 mm. or more), intermediate sizes being relatively uncommon. Coincident with (or somewhat preceding) the change in the seminal vesicles and prostate is the accumulation of sperm in the cauda epididymes, causing a marked swelling in the tubules. These two conditions can

readily be determined with the naked eye, and thus fecundity can be established and recorded in the field.

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THE GENERA OF THE CHIROPTERAN FAMILY NATALIDAE

BY WALTER W. DALQUEST

Bats of the family Natalidae occur principally in the islands of the West Indies, including some islands off the coast of Venezuela. One species occurs on the mainland of North America, where it ranges from Panamá northward to Baja California, México. Another species is found in South America, from British Guiana southward to Brazil.

In 1907, Gerrit S. Miller, Jr., revised the families and genera of the bats of the world. The Natalidae were briefly dealt with (pp. 180–188), and four genera were characterized. Seemingly no one has made a first-hand re-investigation of the status of the genera of this family, although Simpson (1945: 58) reduced two of the nominal genera of Miller to subgenera of the genus *Natalus*. No special reason for his action was given, and it may be assumed that this reduction to subgeneric rank was in accordance with his stated policy regarding the bats (*loc. cit.*: 180): "The genera of recent specialists also appear to me excessively split . . . and I have given many of the genera broader scope than is currently granted by specialists . . . ."

Although Miller does not so state, it is apparent from his paper that he had no specimens of his genus *Nyctiellus* preserved in alcohol. Specimens of this genus preserved in alcohol have been collected in the forty-three years that have elapsed since Miller did his work. Consequently it would be appropriate, in view of the action by Simpson, to re-examine the status of the genera of the family Natalidae.

E. Raymond Hall, of the University of Kansas Museum of Natural History, has kindly loaned to me several specimens of *Natalus mexicanus saturatus* Dalquest and Hall, taken in a cave three kilometers east of San Andrés Tuxtla, Veracruz. This material includes entire animals preserved in alcohol, and com-

plete skeletons. Some of these specimens were dissected and some of the tissues were sectioned and examined histologically. Colin C. Sanborn, of the Chicago Natural History Museum, has loaned me specimens of *Nyctiellus lepidus* Gervais, from Miller's Cave, Long Island, Bahamas, and *Chilonatalus micropus* (Dobson), taken at Windsor, Jamaica. An alcoholic specimen, with the skull cleaned, of *Phodotes tumidirostris* (Miller), was borrowed from David H. Johnson, United States National Museum. The specimen was taken on the island of Curacao, off the coast of northern Venzuela. This material includes the species that are the types of three of the nominal genera of Miller (*Phodotes*, *Chilonatalus*, *Nyctiellus*). *Natalus mexicanus* is closely realted to *Natalus stramineus*, the type of the genus *Natalus*.

The study of this material shows that all of the four forms are species of a single genus, *Natalus*. For the discussions and comparisons in the following pages, however, the current names are used, for reasons of convenience. *Phodotes* is so similar to *Natalus* (in the restricted sense) that *Phodotes tumidirostris* may prove to be only a subspecies of *Natalus stramineus*. The differences separating *Chilonatalus* and *Nyctiellus* are greater, and subgeneric separation of these forms seems practical. The differences between the subgenera, however, are no greater than those found between species within some of the better known Chiropteran genera, such as *Myotis* and *Eptesicus*.

Systematically, the family Natalidae is closely related to the families Furipteridae Miller and Thyropteridae Miller. All three families have much the same geographic range. These three families seem to constitute a unit, and each consists of a single genus. They show relationship to the family Vespertilionidae Gray, and, more distantly, to the family Phyllostomatidae Coues and Yarrow.

Bats of the family Natalidae are of small size; most species are less than 110 millimeters in total length. The body is slim and the wings, legs, and tail are long and slender. The tail is completely enclosed in the interfemoral membrane, and the base of the thumb is bound to the wing by membrane. The fur is soft, long, and lax. The colors vary from gray, buffy, yellowish, and reddish to deep chestnut. The eyes are small and are not prominent. The ears are large, and are funnel-like in shape. Adult males possess a large, gland-like organ on the face or muzzle, which is here named the natalid organ. The skull is delicate and elongate, with swollen, rounded braincase and narrow, somewhat tubular rostrum. There are 38 teeth, 19 on each side, as follows: two upper and three lower incisors, one upper and one lower canine, three upper and three lower premolars, and three upper and three lower molars.

The four forms here dealt with differ in cranial characters and external features. The cranial differences include slight variations in the shape of the skull and variations in the relative size of the teeth. External characters include the size and position of the ducts of the pararhinal glands and natalid organs, shape of the ears, development of the groove in the lower lip, and relative length of the legs. There are other differences, such as size, color, and the minor differences in the skull, but these seem to be of even less taxonomic worth, and certainly are not criteria of more than specific weight.

Skull.—The skull of *Phodotes* closely resembles that of *Natalus*, save that the maxillaries are more inflated, and thus the molar teeth are not visible from above, as they are in *Natalus*. The skull of *Chilonatalus* differs from that of *Natalus* principally in having the rostrum longer and more tipped up, so that the horizontal dorsal surface of the rostrum rises from the base of the rostrum to the tip. The skull of *Nyctiellus* shows the greatest departure from that of *Natalus*. The braincase is lower, and less inflated than that of *Natalus*. The rostrum, although long, is not tipped up from the base, like that of *Chilonatalus*, but descends from base to tip, as in *Natalus*. The dentition of *Natalus*, *Chilonatalus*, and *Phodotes* is similar. In comparison with these forms, *Nyctiellus* differs in that the canines are relatively small, and the first premolars, above and below, are much reduced in size. In *Natalus*, *Phodotes*, and *Chilonatalus*, the first premolar is only slightly smaller than the second. In *Nyctiellus*, the first premolar is less than one-fourth the size of the second.

Cranially, *Natalus*, *Phodotes*, and *Chilonatalus* are very similar. *Nyctiellus* differs in having the braincase lower, less inflated, and in having the canines and anterior premolars reduced in size. The differences, however, that separate *Nyctiellus* from the other forms, are all differences in relative size. The differences are all less than those usually considered to separate genera, and are of the magnitude usually used to separate species.

The pararhinal glands.—This holocrine gland has previously been reported only in the European bat, *Noctula noctula*. It is present in many, if not all, bats of the suborder Microchiroptera. Normally it consists of a number of small lobules beneath the skin, in the anterior, lateral portion of the muzzle of the bat. The secretion of the gland is a dense, yellowish liquid consisting of degenerated glandular cells.

The histology of this gland has been investigated in *Noctula noctula* by Harrison and Davies (1949). In that bat the gland consists of small lobules, separated by fine tracts of connective tissue. The glandular lobules are drained by radially-spaced terminal ducts which, in turn, drain into common ducts which are associated with hair follicles. The secretion of the ducts is expelled onto the surface of the muzzle. Strands of the striped skin muscle separate the lobes and glandular masses, and probably assist in expelling the secretion of the gland.

In the family Natalidae the pararhinal glands are greatly developed. The anterior portion of the muzzle is so greatly swollen by the glandular masses that the nostrils are forced far anteriorly, onto the upper lip. In *Natalus*, the anterior portion of the muzzle is thickened generally by the glandular masses, which extend back onto the muzzle to a point above the corner of the mouth. In *Nyctiellus*, the glandular area and its ducts is more centralized, and forms a rounded swelling at the tip of the muzzle. In *Chilonatalus*, the glandular area and its ducts is so greatly developed and concentrated as to form a high projection, referred to by Miller as a "rudimentary nose leaf."

Histologically, no difference can be noted between the pararhinal glands of *Natalus* and those described and figured by Harrison and Davies, save that the glandular tissue seems to be present in greater amount in *Natalus*.

The natalid organ.—All adult male bats of the family Natalidae, in so far as they have been investigated, possess on the head a unique organ composed of cells that closely resemble sensory cells, but also show evidence of glandular function. In so far as known, this organ is found only in the family Natalidae. The only previous investigator to notice this organ is Miller, who referred to it as a "large, glandular swelling between and in front of the eyes." Miller thought that the organ was confined to the genus *Chilonatalus*, but this is not the case.

The natalid organ in *Natalus* is not conspicuous externally. Upon dissection, however, the organ is found to be larger than in the other members of the family. In a specimen of *Natalus mexicanus*, the organ measured: greatest length, 13 mm.; greatest breadth, 7 mm.; thickness, 2 mm.; width of the anterior ligament, 2 mm.

The natalid organ in *Natalus mexicanus* is a bell-shaped, flattened mass that covers the entire frontal region of the head. It lies freely between the skin and the underlying muscle. A few strands of fascia connect the edges of the organ with the muscles below. The organ is completely independent of the skin. The anterior ridge is a ligament of fascia and connective tissue that ties the organ to the terminal, cartilaginous, portion of the muzzle.

The natalid organ is most prominent externally in *Chilonatalus*, where it forms a rounded, bulging sack on the dorsal surface of the head, between the anterior bases of the ears. The anterior edges of the ears are actually tied to the skin covering the organ by a dermal ridge. In *Chilonatalus*, the organ measures two and one-half mm. in diameter. The narrow anterior ridge leads from the anterior border of the organ to a point above the tip of the rostrum.

In *Nyctiellus*, the natalid organ is but slightly less distinct than in *Chilonatalus*. It is rounded, similar in shape to the organ of *Chilonatalus*, and is larger, relative to the size of the bat. It is situated farther anteriorly than it is in *Chilonatalus*, considerably ahead of the eyes, and the anterior edges of the ears approach, but do not come into contact with, the skin covering the organ. In *Nyctiellus*, the skin covering the organ is sparsely haired. In *Chilonatalus*, the skin over the organ seems to be naked. The narrowed anterior ridge of *Nyctiellus* is short, so much so as to appear only as a constriction between the natalid organ and the swollen area of the pararhinal glands at the end of the muzzle.

No specimens of *Phodotes* with the skull in the head are available. In the alcoholic specimen at hand, however, a part of the anterior ridge is visible on the internal side of the skin. The gland in this form is probably like that of *Natalus*.

The natalid organ of an adult male *Natalus mexicanus* was removed and sectioned. The organ consists of an intertwined mass of tubules, which, in places, are more than one mm. in length in sections ten microns in width. The tubules are perhaps as long as the gland. The tubules are oval to round in cross section, and from 160 to 270 microns in outside diameter. They are separated by narrow strips of connective tissue, 12 to 24 microns in width. Within the tubules is a lining of long, slim, columnar cells, 30 to 60 microns in length and averaging 8 microns in diameter. The nuclei are basal, four to ten microns from the con-

nective tissue sheath of the tubules (semi-stratified), are round, and measure eight to nine microns in diameter. Distally each cell possesses what appears to be an extremely heavy terminal bar, and these bars form a line about the internal diameter of the tubule. Irregularly rounded, non-nucleated bodies of protoplasm project inward past the terminal bars for a distance of eight to 15 microns into the central duct of the tubules. These central ducts of the tubules measure 90 to 160 microns in diameter.

The lower lip.—The lower lip of the Natalidae is fleshy and greatly developed. The lip shrinks soon after preservation in alcohol. Below the lip, in *Chilonatalus*, there is a deep groove. This groove is represented in *Natalus* by only a shallow invagination, and in *Phodotes* and *Nyctiellus* it is not present.

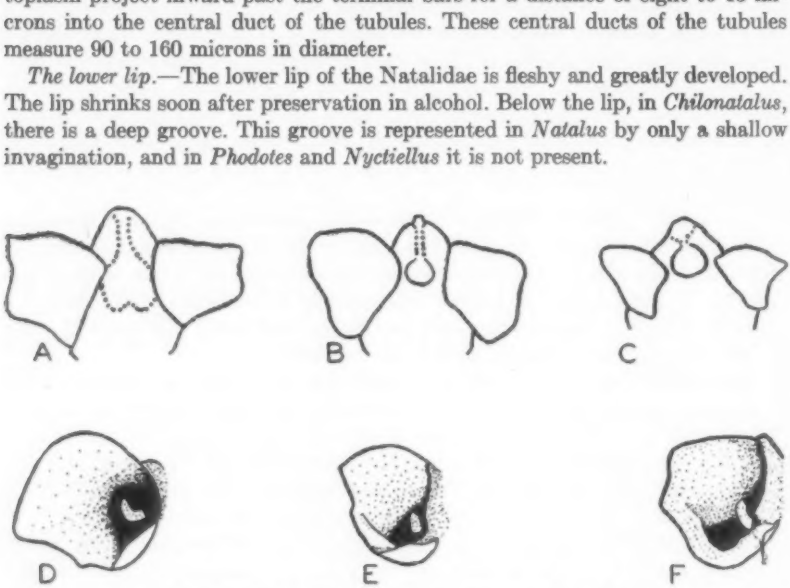

FIG. 1.—Camera lucida drawings. Heads, × 1, from dorsal view, of (a) *Natalus* (*Natalus*) *mexicanus*, (b) *Natalus* (*Chilonatalus*) *micropus*, (c) *Natalus* (*Nyctiellus*) *lepidus*. The outline of the natalid organ, the anterior ridge, and the area of the pararhinal gland and its ducts, has been dotted in when these are not prominent externally. Ears, × 1.3, of (d) *Natalus* (*Natalus*) *mexicanus*, (e) *Natalus* (*Nyctiellus*) *lepidus*, (f) *Natalus* (*Chilonatalus*) *micropus*.

The lower lip of *Natalus mexicanus* was removed and sectioned. The lingual side possesses a deep oral epithelium. Between the oral epithelium and stratified epithelium of the skin, with its associated hair follicles, was found only striated muscle and some fatty tissue. No glandular tissue was present. There possibly is a glandular area of specialized function in the lower lip of *Chilonatalus*, which has a lower lip more greatly developed than does *Natalus*, but this seems improbable in view of the complete absence of such tissue in *Natalus*.

Ears.—Miller's description of the ears of *Nyctiellus* was apparently based upon dry specimens. Although the ears of this form are relatively small and have a sub-terminal constriction that gives a somewhat pointed effect, there is little resemblance to the ear of *Myotis*. The ears are funnel-shaped, as in the other members of the family. Indeed, the ears of *Nyctiellus* are, in some respects, in-

termediate between the ears of *Natalus* and *Chilonatalus*. This is brought out in the camera lucida drawings (Fig. 1). In *Natalus*, the posterior border of the ear is nearly straight, with a median lobe. In *Nyctiellus*, the portion of the ear above the lobe is slightly constricted. In *Chilonatalus*, the area above the lobe is slightly truncated, forming an angle of 30 degrees with the posterior margin of the ear. The ear of *Phodotes* is essentially like that of *Natalus*.

Length of leg.—Miller states (*op. cit.*: 186) that the length of the leg in *Nyctiellus* is much less than that of other Natalidae. Expressed as relative size, however, the leg of *Nyctiellus* is not significantly shorter than in some other forms. For example, when the length of the leg is divided by the length of the forearm, an index of relative length is obtained. In the species studied, the indices rank

TABLE 1.—*Comparison of characters in the Natalidae*

CHARACTER	NATALUS	CHILONATALUS	NYCTIELLUS
Braincase shape	rounded	rounded	flattened
Rostrum	tipped down	tipped up	tipped down
Dentition	normal for genus	normal for genus	first premolars and canines reduced in size
Duct area of pararhinal glands	forming generally swollen area on muzzle	forming high swelling on muzzle distally	forming broad, low swelling on muzzle distally
Natalid organ	large, bell-shaped, covering facial area	medium sized, rounded, on base of muzzle	small, rounded, on median part of muzzle
Lower lip	shallow invagination	deeply grooved	no invagination or cleft
Ears	straight beyond median lobe, large in size	truncated to 30° angle beyond median lobe, large in size	constricted beyond median lobe, smaller in size
Index of forearm to tibia	59	50	47

as follows: *Nyctiellus*, 47; *Chilonatalus*, 50; *Phodotes*, 54; *Natalus*, 59. The indices of additional members of the family, and additional specimens of the species here studied, might show that the leg of *Nyctiellus*, relative to the length of the forearm, is within the range of variation of *Chilonatalus*.

The four nominal genera of Miller, *Natalus*, *Phodotes*, *Chilonatalus*, and *Nyctiellus*, are not separated by differences of a magnitude to warrant recognition of any one of the forms at generic rank (Table 1). *Phodotes* differs least from *Natalus*. Both *Nyctiellus* and *Chilonatalus* differ from *Natalus*, and resemble each other, in the shape of the natalid organ, concentrated area of the pararhinal gland and its ducts, and relative length of the tibia. Cranially, however, *Natalus* and *Chilonatalus* are smiliar and *Nyctiellus* is most different. Consequently it would seem advisable to separate the genus *Natalus* into three subgenera: *Natalus* (including *Phodotes*), *Chilonatalus, and Nyctiellus*. It may be that, when additional material from the islands of the West Indies is obtained, the relatively

slight morphological gaps between the three subgenera will be bridged, and that all three subgenera will be considered as nothing more than species of *Natalus*.

The following brief summary of described forms and ranges is derived from the literature. Eventual reduction of some of the nominal species to subspecies seems probable when additional material from other islands of the West Indies becomes available.

GENUS **NATALUS** Gray
SUBGENUS *Natalus* Gray
Natalus stramineus Gray

Natalus stramineus Gray, Mag. Zool., Bot., 2: 496, 1838.
Type locality.—Unknown.
Range.—Known from Trinidad, British Guiana, and Brazil (see Sanborn, 1941: 380). The range of this species probably extends from the Island of Trinidad and Venezuela southward, along the Atlantic Coast of South America, to Brazil.

Natalus mexicanus mexicanus Miller

Natalus mexicanus Miller, Proc. Acad. Nat. Sci. Philadelphia, p. 399, 1902.
Type locality.—Santa Anita, Lower California, Mexico.
Range.—Northwestern Mexico, including Baja California, Sonora, and Chihuahua. This form intergrades smoothly with *Natalus mexicanus saturatus*.

Natalus mexicanus saturatus Dalquest and Hall

Natalus mexicanus saturatus Dalquest and Hall, Proc. Biol. Soc. Washington, 67: 153, 1949.
Type locality.—Three kilometers east of San Andrés Tuxtla, Veracruz, Mexico.
Range.—Eastern Mexico, including the states of San Luis Potosí, Veracruz, and Campeche. Specimens of *Natalus* from Panamá (Allen, 1904: 78) and Costa Rica (Goodwin, 1946: 329) have been referred to *Natalus mexicanus* and may be referable to this race. It is possible that both *mexicanus* and *saturatus* are subspecies of *stramineus*.

Natalus major Miller

Natalus major Miller, Proc. Acad. Nat. Sci. Philadelphia, p. 398, 1902.
Type locality.—Savaneta, Dominican Republic.
Range.—Known only from the Island of Hispaniola: Dominican Republic (type locality) and Haiti (Sanborn, 1941: 280).

Natalus dominicensis Shamel

Natalus dominicensis Shamel, Proc. Biol. Soc. Washington, 41: 67, 1928.
Type locality.—Island of Dominica, Lesser Antilles.
Range.—Island of Dominica.

Natalus primus Anthony

Natalus primus Anthony, Bull. Amer. Mus. Nat. Hist., 41: 642, 1919.
Type locality.—Cueva de los Indios, Daiquiri, Cuba.
Range.—Known only from skeletal remains from the Island of Cuba.

Natalus tumidirostris Miller

Natalus tumidirostris Miller, Proc. Biol. Soc. Washington, 13: 160, 1900.
Phodotes tumidirostris Miller, Proc. Biol. Soc. Washington, 19: 85, 1906.
Type locality.—Island of Curacao, Venezuela.
Range.—Known only from the type locality.

SUBGENUS *Nyctiellus* Gervais

Natalus lepidus (Gervais)

Nyctiellus lepidus Gervais, Exped. du Comte de Castelnau, Zool., Mamm., p. 84, 1855.
Type locality.—Cuba.
Range.—Cuba, Isle of Pines, and Cat and Long islands, Bahamas.

SUBGENUS *Chilonatalus* Miller

Natalus micropus Dobson

Natalus micropus Dobson, Proc. Zool. Soc. London, p. 443, 1880.
Type locality.—Kingston, Jamaica.
Range.—Jamaica.

Natalus brevimanus Miller

Natalus (Chilonatalus) brevimanus Miller, Proc. Acad. Nat. Sci. Philadelphia, p. 328, 1898.
Type locality.—Old Providence Island, off the coast of Nicaragua.
Range.—Old Providence Island.

Natalus macer (Miller)

Chilonatalus macer Miller, Proc. Biol. Soc. Washington, 27: 225, 1914.
Type locality.—Baracoa, Cuba.
Range.—Cuba.

Natalus tumidifrons (Miller)

Chilonatalus tumidifrons Miller, Proc. Biol. Soc. Washington, 16: 119, 1903.
Type locality.—Watling Island, Bahama Islands.
Range.—Watling Island.

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Louisiana State University, Museum of Zoology, Baton Rouge, Louisiana. Received March 17, 1950.

NOTES ON THE RACCOON IN SOUTHWEST WASHINGTON

By Victor B. Scheffer

The Willapa National Wildlife Refuge, Pacific County, Washington, is a favorite haunt of the raccoon, *Procyon lotor psora*. Long Island, the backbone of the refuge, is about six miles long and is clothed with a dense jungle of huckleberry bush and evergreen timber. On the tidal beach that bounds the island there are many crabs, oysters, mussels, and other shellfish upon which the raccoons feed.

The refuge manager is able to harvest each winter about 100 raccoons. In so doing he controls their predation upon pheasants and ducks, and he brings in to the Government a revenue from the sale of skins. In 1946 he arranged, for the benefit of science, to spread the take of raccoons throughout all months of the year. The Washington State Department of Game issued a permit for the hunting and trapping of raccoons outside of the regular season.

The present paper reports on the measurements, with certain field notes and interpretations, of 127 raccoons taken between July 13, 1946, and February 20, 1948. A report on the stomach contents of the animals is published beyond (p. 448). Eighty-two of the specimens were taken by Maurice L. Hinshaw and 45 by Earl M. Brooks. Full credit is due these men for the hard work they did in collecting and measuring the specimens. (Mr. Hinshaw lost his life in May 1947 while attempting to retrieve his boat on a 'coon hunting trip.) Of all the specimens taken, about two-thirds were shot and one-third trapped. Spotlighting at night from a power boat was successfully used. By months, the following numbers of raccoons were collected: January, 9; February, 19; March, 10; April, 7; May, 4; June, 0; July, 11; August, 10; September, 10; October, 20; November, 10; and December, 17. The measurements of four bob-tailed individuals are excluded from discussion here, leaving a balance of 123 specimens.

Age groups.—Three distinct age groups (summer young, yearlings, and adults) are revealed in a histogram of the length frequencies (Fig. 1). The mean length of each group is, roughly: summer young, 475 mm.; yearlings, 625 mm.; adults, 775 mm.

The weight frequencies do not show the three groups distinctly (Fig. 2). The weights vary widely and the boundaries of the age groups are obscured by overlapping. You will see that the histogram for weights of females, as compared with the similar diagram for males, reveals an absence of heavy individuals. While the histogram proves that a number of fully adult females were included in the sample, these individuals were poor in weight, probably because they were lactating.

Hoping to understand the age groupings through analysis of body weights, the writer studied the measurements of 20 males and 30 females, from the period August to October only. The study showed a distinct clustering of summer young in the neighborhood of weights 3 to 4 pounds, and a blending of yearlings and adults in the neighborhood of weights 9 to 11 pounds. The yearlings were indistinguishable from the adults.

The size of the adult raccoon.—From his collection of 82 specimens, Mr. Hin-

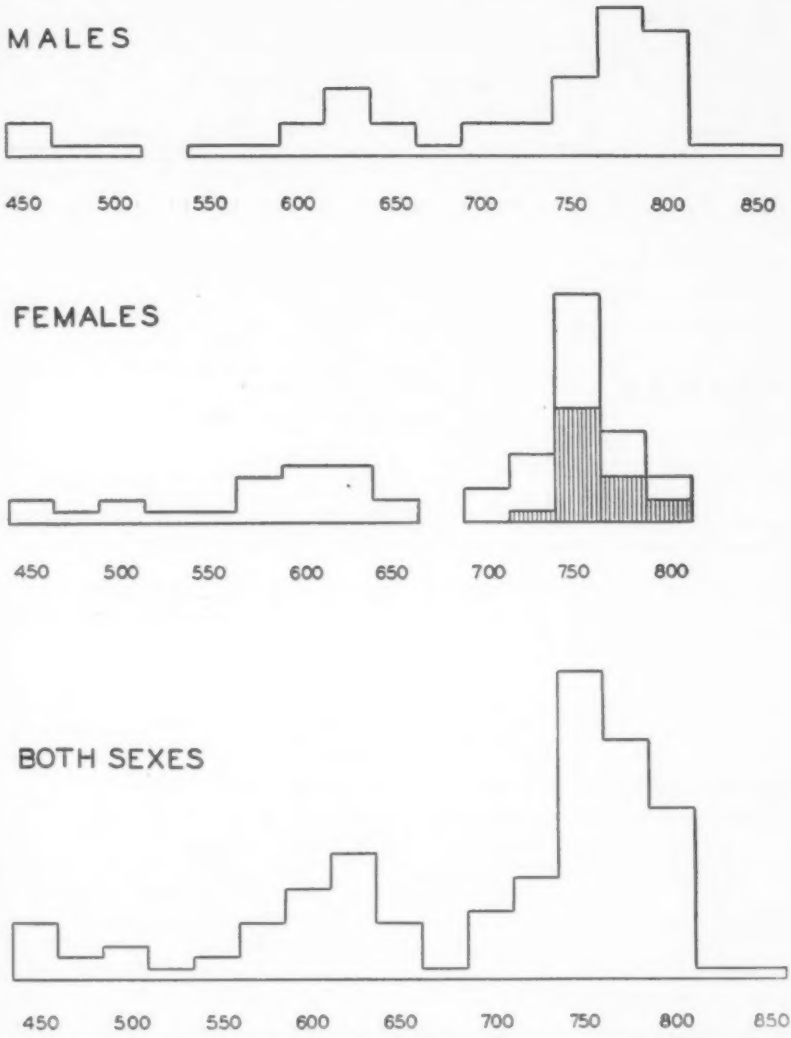

FIG. 1.—Variation in body length (in millimeters) of 59 male and 64 female raccoons taken from Long Island in all months of the year except June. The shaded areas represent lactating females.

shaw saved 68 skulls. The ones he discarded had been shattered by bullets or were the skulls of young animals. Later, the writer cleaned the skulls and selected 44 of them that showed, by the attrition of the teeth, that they were adult.

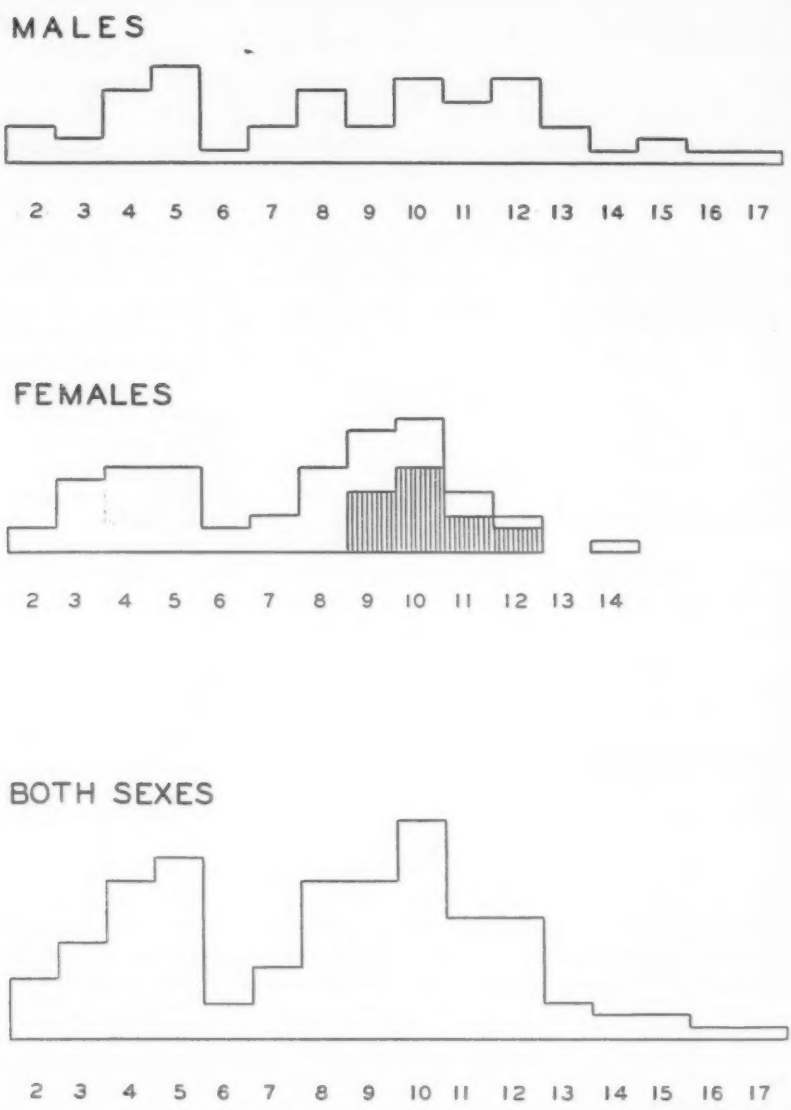

FIG. 2.—Variation in body weight (in pounds) of 59 male and 64 female raccoons taken from Long Island in all months of the year except June. The shaded areas represent lactating females.

These skulls are now deposited in the Biological Surveys Collection of the National Museum.

From the combined Hinshaw-Brooks sample of 123 specimens (excluding bobtailed ones) the writer has analyzed the measurements of the 30 longest males and the 30 longest females. This group of 60 includes only adults with worn teeth. Near the lower boundary of the group the adults and the yearlings intergrade to a slight extent. No yearlings are included in the 60. Several adults, however, are excluded from the 60 where these adults are shorter in body length than the yearlings. In brief, the writer has tried to select a sample of 60 representative adult raccoons.

The data in Table 1 support the conclusion that the male raccoon is, with respect to the female, (1) 2.6 per cent longer (when the arithmetic means are compared), (2) 8.6 per cent heavier (when the arithmetic means are compared),

TABLE 1.—*Parameters of the 30 longest males and the 30 longest females in the sample of 123 raccoons from Long Island*[1]

	ARITHMETIC MEAN	GEOMETRIC MEAN	RANGE	COEFFICIENT OF VARIATION, PER CENT
	Males			
Length, millimeters	784	784	750–853	3
Weight, pounds	11.5	12.7	7.3–17.0	22
	Females			
Length, millimeters	763	762	744–805	2
Weight, pounds	10	9.87	7.2–14.1	11

[1] Computed by Mary Jean Sparks.

and (3) 28.6 per cent heavier (when the geometric means are compared). The geometric mean is often accepted as the parameter most useful in comparing body weights. The writer emphasizes that his conclusions as to sex discrepancy are based on a run-of-the-mill sample and not on specimens of exactly known age. Strictly speaking, sex discrepancy in a species should be determined by comparing individuals of the same age, as well as from the same environment.

Considered as a group, the 17 lactating female raccoons measured: length in millimeters, 759 (733–805); weight in pounds, 10.1 (9.1–11.8).

Breeding and early life.—A few brief notes from Hinshaw's catalog are of interest here: April, 1947: Males and females were found in pairs. April 30, 1947: A female specimen contained 3 large fetuses. She was 747 mm. long and weighed 11.8 pounds. May 19, 1947: An adult male was seen travelling with another adult, probably a female. Only the male was collected. August 28, 1946: Two young, the first seen this summer, hunting with mother. Two other young, hunting with a lactating mother. August 30, 1946: Two young hunting with lactating mother. These were the smallest young in the entire collection, a male weighing 2.0 pounds and a female weighing 1.8 pounds. September 10, 1946: Two young hunting with mother. September 11, 1946: Two young hunting with lactating mother. Another young hunting with mother.

In the preceding notes you will see that young are reported in the following frequencies: 1–2–2–2–2–2–3. Perhaps it is due to chance sampling that the litter size appears to be low. In various other parts of the United States, the litter size of the raccoon is reported as from 3 to 8.

Of the 17 females thought to be yearlings (Fig. 1), none was reported to be lactating. Of the 23 females thought to be adult, 17 were reported to be lactating. The conclusion is that most of the female raccoons on Long Island are not impregnated in their first winter. Frederick W. Stuewer found that certain yearling female raccoons bred successfully (Jour. Wildl. Mgt., 7:60–73, 1943). Clifford H. Pope found that both male and female raccoons mated in captivity in their first year (Jour. Mamm., 25:91, 1944).

Of 127 raccoons collected on the Willapa refuge 63 were males and 64 were females.

Evidence of fighting.—In his field catalog of 82 specimens, Hinshaw occasionally noted animals found with scars and injuries. Fourteen males and nine females were thus reported. Most of the scars were on the ears and the tail; a few on the limbs.

United States Fish and Wildlife Service, Seattle, Washington. Received December, 1948.

GENERAL NOTES

SUMMER FOOD HABITS OF THE RACCOON IN SOUTHWEST WASHINGTON

Material examined.—Between July 13 and September 28, 1946, the stomachs of 29 raccoons (*Procyon lotor psora*) were collected on the Willapa Harbor National Wildlife Refuge, Pacific County, Washington, where raccoon were overabundant. Most of the animals were shot during morning hours while they were still feeding. Included were 20 females and nine males. Of the females, 15 were adults in milk and five were young, all but one with its parent. Perhaps the extra food requirement while suckling young made it necessary for the adult females to be in search longer or more often for food, thus accounting for the larger proportion of this sex in the sample.

The nine immature animals ranged in weight from 2 to 2.9 pounds, with an average of 2.5 pounds. The 20 mature animals ranged from 7.4 to 13 pounds, with an average of 10 pounds. (For a report on the weights and measurements of 127 raccoon, including the specimens of the present paper, see Scheffer, Jour. Mamm., 31: 444, 1950.)

The stomachs, all of them containing food, were preserved in formalin by Maurice L. Hinshaw of the U. S. Fish and Wildlife Service, and were sent to the Department of Wildlife Management, State College of Washington, for analysis.

Method of analysis.—A stomach was opened, and its contents were placed in a graduated cylinder of appropriate size. The cylinder was tapped uniformly to facilitate consistent and accurate measurement. After measuring, the food was placed in a sieve and held under a faucet so that formalin and very small particles were washed away. The remainder, free of mud and finely masticated particles, was placed in a porcelain tray and subsequently separated as to phylum, family, and genus. After the first separation, the specimens were identified by the writer. Later, Robert H. Whittaker of the Department of Zoology, State College of Washington, checked the identification.

Results.—As indicated in Table 1, the stomach contents were composed almost entirely of tidewater and mudflat animals. The only other item was mother's milk. Nurslings, including at least seven of the nine young, were taking milk along with beach organisms. In

addition to the items listed in the table, traces of grass were present, perhaps adventitiously, in eight adult and two young stomachs. Some mussel *shells* were present. Light infestations of nematodes (*Porroceacum* sp.) occurred in the stomachs of eleven adults. The 29 stomachs contained food ranging from 12 to 385 milliliters, with an average of 119. The average for nine young animals was 23 milliliters; the 20 adults averaged 163.

The absence of plant food is noteworthy since the raccoon, in other parts of the United States, has the reputation of being omnivorous or even predominantly herbivorous. While edible berries of the genera *Rubus*, *Symphoricarpos*, *Vaccinium*, *Gaultheria*, and *Berberis* occur on the Willapa Refuge where the raccoons were taken, none appeared in the stomach

TABLE 1.—*Stomach contents of raccoons from southwest Washington*

ITEM	FREQUENCY		VOLUME	
	Number of Stomachs in which Item Occurred	Percentage Occurrence of this Item in all Stomachs	Mean Volume in Milliliters	Percentage Volume of this Item in all Stomachs
20 Adults				
Mollusca: Mytilidae (mussels) and *Ostrea* (oyster)	17	85	70.5	44
Crustacea: *Crago nigricauda* (black-tailed shrimp), *Emerita* (mole crab), and *Ocypoditae* (fiddler and sand crab)	17	85	40.5	25
Pisces: *Clevelandia* (goby) and *Leptocottus armatus* (cabezon)	13	65	14.8	9
Annelida: *Nereis* (marine worm)	10	50	31.6	20
Echiurida: *Urechis* (mudflat worm)	5	25	1.9	1
9 Young				
Crustacea: *Crago nigricauda* (black-tailed shrimp) and *Ocypoditae* (fiddler and sand crab)	9	100	11.5	50
Mollusca: Mytilidae (mussels)	6	67	7.0	30
Milk	7	78	4.3	18
Pisces: *Clevelandia* (goby)	4	45	0.4	2
Echiurida: *Urechis* (mudflat worm)	1	11	trace	trace

contents. The conclusion seems reasonable that the raccoons took the food items which they preferred. EDWIN L. TYSON.—*Department of Wildlife Management, State College of Washington, Pullman. Received March 4, 1950.*

HYBRIDS OF THE POLAR AND KADIAK BEAR

The report of The National Zoological Park, Washington, D. C., for 1949, lists four hybrid bears, *Thalarctos maritimus* x *Ursus middindorffi*. I wish to report subsequent matings of these two genera. The method of the first mating and the events that terminated in the birth of cubs is a trifle obscure. It is my recollection that the male found himself in the enclosure with the female, without the planned introduction on the part of keepers. Nevertheless, the polar bear male was seen to mate with the Kadiak bear female; in fact several copulations took place. Regardless of the details, the polar bear sired a litter of three hybrid cubs in the winter of 1936. The exact period of gestation was not recorded, but the mating took place in the spring and the young were born about February 21, 1936. It is assumed that this cross would not have occurred in nature, for the ranges of the two species do not overlap.

The 1936 litter possessed much vitality, thereby startling the biological world as they grew to maturity. A planned mating occurred in 1938, and at the termination of a gestation period of 180 days a second hybrid litter appeared, in 1939. These two litters grew to maturity and the individuals became unusually large. We had an occasion to destroy one male, due to a large open wound on its flank. He weighed 1160 pounds. There were two males and a female in each of the litters. These youngsters appeared normal and weighed about two pounds each at birth. The approximate three-year lapse between the two litters is attributed to the period in which the mother cared for and reared her offspring. The coat color of the cubs was a grayish buff, a sort of blend of the coat characterists of their sire and dam. I suggest that heterosis played a part in the ability of the young to thrive and mature. For the F_2 generation, two female hybrids, one from each previous litter, were mated with their full brother, and two litters were born on January 2 and 3, respectively. These two animals produced young at two previous periods, but they lived only a few hours. At this date it is impossible to determine the exact number of offspring, and we can only surmise that several exist. Today, February 1, 1950, I was fortunate to be able to scrutinize one of the youngsters. Its eyes are closed. The general color is a grayish buff, and it has a small white streak on its mid-ventral section. Around the sides of its neck are two white crescent markings. These polar bear white marks embrace the sides of the neck, but do not join on the dorsal or ventral surfaces. The cub appears in good flesh, its teeth have not budded, and its voice indicates that there is much vigor, regardless of its hybrid and inbred background. The artificial environment of captivity, and the proximity of a female in the period of the oestrum, contributed much to these matings.

On February 3, we were able to determine that only one cub was alive, and on the next day the mother abused her baby to such an extent that it became necessary to remove the offspring. This operation was most difficult, for although the mother maltreated and refused to nurse her young, she was reluctant to part with it.

Upon its removal we wrapped the cub in a blanket and fed it warm milk with an eye dropper. Later in the day the female cub was fed from a nursing bottle upon a simulated bitch's milk formula. The specimen is the animal that displays the decorative crescent collar. It now appears that this orphan cub will develop into one of the stars of the collection. The fact that two forms belonging to the genera *Ursus* and *Thalarctos*, respectively, produced hybrids to the F_2 generation may indicate that their systematic position is closer than their present classification indicates.—Malcolm Davis, *The National Zoological Park, Washington, D. C. Received February 11, 1950.*

NOTES ON THE HOOD SEAL (*CYSTOPHORA CRISTATA*)

During my second trip to the ice fields off Northern Newfoundland (as surgeon to a fleet of fourteen vessels) in the Spring of 1948, I had the opportunity to study to some extent the hood, or bladder nose seal (*Cystophora cristata*).

These seals, less numerous and of less economic importance than the harp seal, live fairly close to, but distinctly apart from, the latter. Both species pup early in March around 55–60 degrees North Latitude, and ride the ice floes down the coast of Labrador. The hood is known as an "outside" seal, that is, it is always found to the east of the harps, anywhere from thirty to one hundred miles or so. (Another important breeding ground of the hood lies to the North of Jan Mayan Island, which "fishery" is prosecuted chiefly by the Norwegians.)

The hood is not particularly popular with the Newfoundland crews as the pelts of the old bring a much lower price on the market than do those of the harp. The young hood is equally as valuable as the "white coat" or young harp, however, but is much less numerous, as will be seen.

Leaving St. John's, Newfoundland, on March 6, 1947, at six P.M., we met heavy ice ten miles off the narrows and were forced to return. The next day we managed to get into Bay Roberts where we ballasted. Half way out of Conception Bay we became jammed. Two days later found us off the Cape and in the southerly flow going rapidly away from the rest of the

fleet which had managed to get down the coast in clear water while we ballasted. We made to the east as much as possible to try to get outside the pack, but it was not until March 18 that we reached the latitude of the Funks. Three days later we ran into the hood seals. The other ships were by this time much farther north and west and were in patches of harp seals.

One always speaks of a family, or families, of hoods. At this time of year the old dog, bitch, and pup are together. Each family unit is rarely closer together than fifty yards or so, or much more, depending on ice conditions. The dog and the bitch will defend the pup in time of any danger and the dog especially is a mean antagonist. All these characteristics are in contrast to the harps who leave their young in patches—thousands to an acre at times —and who are never around to defend them.

The young hood is born shed of all lanugo (this is seen as "hair discs" in the amniotic sac often found on the ice) and is fully able to swim. They rarely do so unless forced to, and it is relatively easy to approach within rifle shot of the family.

If the old dog takes to the water out of range, that is of no consequence. The men go on either to shoot or to bat the bitch, and always to bat the pup. A gaff similar to a light boat hook is used for this purpose. Soon the dog will be back and can be shot. At such times he is very vicious and no one man will attack him with a gaff for he can get over the ice as fast as a man for a short distance. Occasionally a party of three or four pelters will be attacked and then there is a lively scuffle.

Sometimes the seal is killed, but often only groggy after all the gaffs have been broken. It is absolutely useless to hit him over the inflated hood. Many amusing stories are told of these encounters, mostly occasioned by loss of clothing and moderate bites. I have, however, never heard of an authentic case of a seal killing a man, though the sealers think it is quite possible.

When a seal is apparently dead it is wise to take some precautions before starting to pelt him. The proper technique is to push your gaff handle down his throat so that he can't bend his neck, as there are authenticated cases of the seal waking up and taking a little more than the seat of the pants off.

Incidents are known of the old dog taking a baby's scudders and hind feet in his mouth and throwing him in the water at times of danger. I have heard also that the dog has returned later to the pan and, finding the bitch dead and pelted, has taken the carcass in his mouth, shaken it as a dog might, and thrown it off the ice.

Of course the interesting thing is why the hood, and why a seal equipped with a presumably useful appendage, is less able to maintain its numbers, while living in an apparently more favorable environment, than is its near neighbor.

Man is certainly the seal's worst enemy, ice accidents to the young probably next, then polar bears, and lastly, sharks. Probably ten harps are killed for one hood by man each year, yet the number of hood seals is relatively small.

What is the hood for? Three obvious speculations are: A battering ram; a secondary sexual characteristic; and something to frighten something with. They were not invented especially for producing fear in man.

Contrary to general belief, the females have the same anatomical features in the hood and skull as do the males, but are not known to inflate the hood. (One of the clearest dissections I was able to make of the hood and appendages was from a new-born bitch.)

The hood, from inside out, consists of a layer of mucous membrane continuous with the mucous membrane of the naso-pharynx. This membrane is over-laid by innumerable muscle fibers originating from the ali nasi and particularly from extensions of the greatly developed frontales muscle interdigitating in a frame work of connective tissue and fat, and covered by skin.

Normally air enters the post naso-pharynx and trachea as through a normal nose each side of the septum. In this seal and in no other that I know of there is a bony defect in the maxillary bone which is more than replaced by a double hinged cartilaginous flap which is capable of completely closing the passage between the external nares and the post naso

pharynx. This flap or check valve is activated by two sets of muscles. Slips from the frontales cover it and go on to an attachment over the nasal bones. Contraction, which is probably a voluntary mechanism, closes the check.

Attached to the inner surface of the cartilage is a muscle inserting in four to five separate bands into the posterior nasal septum, which by contraction aids in sealing the valve. This muscle might be involuntary, but as yet I have no microscopic sections to prove it.

Thus the cavity between the anterior and posterior nares are separated. To prevent deflation of the hood through the nares there are strong sphincteric muscles closing the nares, aided by a very redundant mucous membrane.

The sealers will tell you that if you get him mad enough "he will blow gert bladders out of his nose." This is so. The redundant mucous membrane is extruded as fiery red paired "bladders" six to seven inches long and five to six inches in diameter.

The hood, from anatomical dissection and from experience with bullets, must have been nature's original self sealing tank. The muscle fibers close on any number of bullet holes and cause the seal little discomfort, apparently. I have seen them make no move or other evidence of annoyance from bullets going through the inflated hood. The hood does not stop the bullet as is generally believed by the men.

The hood, when fully extended, holds about six quarts of water, and by filling the hood of a severed head the efficacy of the check valves can be tested. They are really very tight. I hung one for four days and recovered the same amount of water originally put in.

This hood and skeletal structural variation is practically the only important variant, anatomically, from the neighboring harps, except for size and color. The dog hood seal is a mottled dark and light brown and is larger than the harp seal. An exceptionally large old dog with well-worn teeth measured ten and a half feet from nose to base of tail. The bitches are somewhat smaller, eight feet being large. The pup weighs between twenty-five and thirty pounds at birth.

These seals are in no immediate danger of extinction principally because of their relative inaccessibility and undesirability. It is hoped that a rational method of cropping can be worked out before it is too late, because under the present type of hunting a complete family unit is wiped out, leaving no potential breeders.—J. M. Olds, *1160 Windsor Avenue, Windsor, Connecticut.* *Received April 4, 1950.*

THE COYOTE AS A SEED DISTRIBUTOR

In the flat, sand- and silt-bottomed floor of the Salton Basin of the Colorado Desert of California there are today large plantings of the date of commerce (*Phoenix dactylifera*). The dates begin to ripen in September and the harvest continues until about the first of January. Considerable numbers of the sugar-filled fruits fall to the ground or, when found to be of poor quality by the pickers, are rejected and cast aside. Desert coyotes (*Canis latrans estor* Merriam) from surrounding wild areas sneak into the orchards at night and eagerly feed on such fruit as they may find.

The Coachella Valley portion of the Salton Basin, where the date orchards are found, is bounded on the northeast by the Little San Bernardino Mountains which rise abruptly from the desert floor to an altitude of 5000 feet or more. Often while doing field work in the small upper canyons and valleys several miles back from the crest I have come upon coyote feces composed almost wholly of date seeds. This means that coyotes, after feeding on dates, travel over rough, steep terrain to the mountain crests before the seeds have had a chance to pass through their bodies. The distance from the mountain highlands to the nearest date orchards is between ten and fifteen miles, even as a coyote goes. Animals living in the mountains probably make the long down and return journey in a single night.

There always has been much speculation concerning the agencies responsible for the planting of the desert's native palm (*Washingtonia filifera*). The local Cahuilla Indians may have been partly responsible, but seeing the way coyotes travel and carry palm seeds I think it is also possible that this fruit-eating mammal may be the most important agent for distribution of the seeds of this wild palm to be found in many scattered colonies about

isolated springs, seepages, and small perennial streams of the mountains bordering the Salton Basin, also about some of the springs in adjacent areas of the southern Mohave Desert. In late summer coyotes often feed on the small, black, palm berries and carry the seeds considerable distances even as they do those of the commercial date.

I feel very certain that coyotes likewise specifically aid in the natural distribution of the several species of desert juniper (*Juniperus*) and of screw bean and honey-mesquite (*Prosopis juliflora* and *P. pubescens*). In mid- and late summer they feed heavily on the fruits. I have removed viable seeds of all these plants from coyote feces; when placed in warm damp soil they readily germinated.—Edmund C. Jaeger, *Department of Zoology, Riverside College, Riverside, California. Received January 20, 1950.*

BACKWARD SWIMMING OF THE MUSKRAT

Cursory examination of the literature fails to produce reference to the ability of the muskrat (*Ondatra z. zibethica*) to swim backwards. Most accounts of muskrat swimming are concerned with mechanics of swimming (Mizelle, J. D., Jour. Mamm., 16: 22–25, 1935, and six references contained therein). Consequently, the following observation will probably be of interest.

While observing waterfowl on November 9, 1949, at 2:00 P.M., at the edge of Mud Lake at the Rose Lake Wildlife Experiment Station (Sec. 27, Bath. Twp., Clinton Co., Michigan), my attention was attracted to a muskrat swimming leisurely fifteen or twenty feet from the dock on which I was standing. After it had moved about twenty feet past the dock, the animal stopped and began to swim backwards, using all four feet in a stroke that resembled the "dog paddle" in reverse. It swam backwards for 30 feet in this manner, maintaining about the same speed as in its forward movement, but with more activity. It appeared to watch me intermittently as it swam along. The 'rat stopped and after a few seconds again began to swim forward in the conventional manner, retracing its former course. It disappeared from view in the cattails 50 feet beyond the dock. The 11-year-old observation file at the Rose Lake Wildlife Experiment Station fails to note muskrats swimming in this unusual manner, and none of the local trappers have ever noticed such behavior.—Arthur Ward Peterson, *Michigan Department of Conservation, Lansing, Michigan. Received February 9, 1950.*

ANOTHER RECORD OF A SWIMMING JUMPING MOUSE

Little has appeared in the literature about the aquatic habits of the genus *Zapus*. William B. Davis (The Recent Mammals of Idaho, p. 334, 1939) offers circumstantial evidence of swimming in the jumping mice of the *Zapus princeps* group, and Norman A. Preble (Jour. Mamm., 25: 200–201, 1944) records the sight of a jumping mouse, which he tentatively identified as *Zapus hudsonius hudsonius*, in the act of swimming. The following account of swimming by a jumping mouse may be of interest.

While working along the Dismal River at the Thomas-Blaine County line, Nebraska, on 1 July 1948, the writer was walking along the river bank in the early afternoon. The Dismal is a wide, shallow, sandy-bottomed stream and the banks support a thick growth of grasses which are waist deep in places. As I walked through the grass, an animal which I thought to be a frog leaped into a side pool which was about six feet long, three feet wide, and two feet deep. Upon investigation I found, to my surprise, a jumping mouse swimming under water in the pool. The front feet of the mouse were laid back against it's body and it's hind feet propelled it through the water at a surprising rate of speed. The tail streamed behind and was apparently not in use. Small bubbles of air were emitted by the mouse at irregular intervals. After about 45 seconds under water, the animal headed for shore and was easily captured as it was coming up at the shore line. The mouse spent about a minute under water and at no time came up for air. It was swimming at an estimated depth of one foot most of the time. Although the mouse was undoubtedly frightened into the water by my movements the incident leads one to believe that this rodent may frequent aquatic habitats more than present knowledge indicates.

The specimen, an adult female, has been identified as *Zapus hudsonius pallidus* by Rollin H. Baker and E. Lendell Cockrum of the University of Kansas Museum of Natural History.—J. Knox Jones, Jr., *Nebraska Game and Parks Commission, Lincoln, Nebraska. Received February 15, 1950.*

GESTATION PERIOD OF THE WOODCHUCK, *MARMOTA MONAX*

A pair of woodchucks were captured near Geneva, New York, as young from a single nest after the mother had been hit by a car in the spring of 1948. The two young were first raised on a bottle and later fed dog biscuits and greens. They were kept in a divided cage on the unheated sunporch in Etna, New York. The two spent the winter in separate cages, only being allowed to come out for exercise when they awoke together throughout the winter. Usually one was asleep when the other was awake.

On March 21, 1949, when the male had been awake for several weeks and active on warmer days and the female had been awake for only a week, the two met outside the cage and showed an interest in each other for the first time since fall.

Each day for the following week the two woodchucks played with each other and romped around the sunporch always under close supervision. Not once throughout this time did the male attempt to mount the female. His testes were conspicuously descended by this time, not having been obvious when he first emerged from hibernation.

The morning of March 29 when the woodchucks were let out for play they immediately entered each others cages and investigated them thoroughly. The male soon returned to his own cage where the female was still snuffling around in the shavings on the floor. Upon entrance of the male the female rose on her hind legs and the two 'boxed' for a few seconds. The male immediately mounted the female, who assumed a position almost like her hibernating position, nose tucked down under her chest, eyes closed, but tail up. The male gripped her fur with his teeth about half way up her back. Copulation continued for about eight minutes, then they separated for a few minutes while they 'preened' a little, then he mounted again for five minutes. After another interruption of several minutes the male again mounted for three minutes after which they lost interest in each other and were placed in their respective cages.

From this day on the two woodchucks were not allowed association with each other at all and only one was exercised at a time. The female became increasingly more fussy and by the 28th day after mating she was very difficult to handle. From this day on we simply furnished food and water and did not allow her out of the cage.

The first young was born sometime between 7:00 and 10:00 P.M. on April 29, making the gestation period in this case 31 days and about 10 hours. Four young were born throughout the night, but due to the hot spell at the time none lived longer than five days.

Within two days after the loss of the last young, the female was quite tractable, and permitted herself to be picked up without biting.—Southgate Y. Hoyt and Sally F. Hoyt, *Department of Conservation, Cornell University, Ithaca, New York, and "Aviana," Etna, New York. Received February 2, 1950.*

A RECORD OF FOX SQUIRREL LONGEVITY

A 6½-year-old fox squirrel (*Sciurus niger rufiventer*), the oldest squirrel in the 11-year record of the Rose Lake Wildlife Experiment Station, was shot on the station in Bath Twp., Clinton Co., Michigan, on October 23, 1949. The squirrel was brought into the station headquarters by a hunter for routine game bag check. Live trapping and tagging of game and fur-bearing animals are routine procedures at the station. Public hunting on a permit basis, with required bag check, facilitates recovery of tagged animals.

Female fox squirrel No. 17,351 was first trapped as a 1-pound, 3-ounce juvenile on September 9, 1943, in an upland, oak-hickory woodlot. Its condition was described as "good," implying freedom from ectoparasites, absence of mange, and a general overall sleek condition. It was not handled again until shot in a lowland elm-aspen woodlot, 1.4 miles east of its first point of capture. When shot it weighed 1 pound, 15 ounces, 2½ ounces heavier than the average weight of 16 adult females shot during the 1949 hunting season.

Assuming that this squirrel was born in mid-March, 1943, (most Michigan fox squirrels are born during the second week in March—Allen, D. L., Michigan Fox Squirrel Management, p. 107, 1943), its age when shot was about 6½ years. During its life span it had survived six hunting seasons, had probably produced ten or eleven litters, and had added a possible thirty squirrels to the game population (*op. cit.*, pp. 110–112).

Previous longevity records for the fox squirrel at the station show that relatively few tagged animals ever reappear in live traps or in the hunters' bag more than four years after initial handling. Only one other record of a fox squirrel whose known age exceeds six years exists at Rose Lake. This second individual, male No. 14,490, was six years, two months old when last live-trapped and had also survived six hunting seasons (Linduska, J. P., Jour. Mamm., 28: 126–129). A review of available literature fails to reveal mention of other probable age limits of the fox squirrel in the wild. It may be that these two animals approached the maximum age attainable under natural conditions in Michigan.—Howard C. Greene, *Michigan Department of Conservation, Lansing, Michigan. Received February 9, 1950.*

A FURTHER NOTE ON THE LONGEVITY OF THE BIG BROWN BAT

The recovery of two banded big brown bats (*Eptesicus f. fuscus*), from Lafleche cave, Gateneau County, Quebec, which were over eight years old, has been previously recorded (Banfield, Jour. Mamm., 29: 418, 1948). On February 20, 1949, the cave was revisited, eighteen bats were banded, and seven recoveries were made. Among the recoveries was a male banded by Harold B. Hitchcock in the same cave on November 25, 1939, and previously recaptured on February 7, 1948. This animal was more than nine years three months old and was the sole survivor of the group banded in 1939.—A. W. F. Banfield, *Dominion Wildlife Service, Ottawa, Canada. Received April 6, 1950.*

OCCURRENCE AND BEHAVIOR OF THE HAWAIIAN BAT

Knowledge of the Hawaiian bat, *Lasiurus semotus* (H. Allen), is scant. Few specimens have been collected, and its occurrence and behavior have been described but rarely. Two specimens in the type series were collected from the Island of Kauai (Allen, Proc. U. S. Nat. Mus., 13: 175), others were merely known to be from the Hawaiian Islands. Our knowledge of its distribution seems to be contained in the statement of R. C. L. Perkins (Fauna Hawaiiensis, 1: 466, 1913), pertaining to the 1890's, that the bat frequented the mountains of the Island of Hawaii and was common locally in the uplands, seldom visited the lowlands, and that he saw it very rarely on Kauai and Oahu. The general distributional picture I have seen on Hawaii agrees only in part with Perkins' information.

I encountered bats occasionally in the course of several years of intermittent residence on Hawaii. Between 1938 and 1949, I was able to collect only about twenty records of the bat, including observations reported to me by other persons. These were well spread out over the months of the year and included the following localities, ranging from sea level to 13,200 feet elevation: **Kau District**—Ninole pond (sea level), Great Cracks (2000 ft.), Half-way House in Kapapala (2900 ft.), Kilauea Iki (3600 ft.), Kilauea Crater (4000 ft.), Kipuka Puaulu (4000 ft.), Kipuka Ki (4500 ft.), Keauhou (4100 ft.), Kipuka Kulalio (5450 ft.), 2 miles above Puu Ulaula (10,800 ft.), and Mokuaweoweo Crater (13,200 ft.); **Puna District**—Kalapana (sea level); **South Kona District**—Honaunau (sea level); **Hamakua District**—Waipio Valley (sea level), Pohakuloa (6600 ft.).

My impression was that bats were to be found most frequently from sea level up to 4000 feet. I did not find any place in the uplands where bats were common. Their occasional presence at higher elevations, even beyond the upper reaches of vegetation, was not surprising on considering that *Lasiurus* is a migratory bat in North America. Bats were seen in both dry and wet areas with yearly rainfall averages of from 20 to 90 inches. Probably they could be recorded from much wetter areas than the wettest of these; however, I never did see them in dense, closed, wet forests. They apparently preferred habitat of either open or mixed character. The existence of open bodies of water or of trees was not essential to bring them into an area. In the middle uplands I noticed them in partly wooded places where

openings such as pastures or lava flows broke up the forest. Occasionally they flew over sparsely vegetated or barren deserts, such as parts of the Kau Desert and the summit area of Mauna Loa.

Times of day in which bats were seen in flight were between 3:00 and 7:00 P.M. Ordinarily they were seen after the sun had set or gone behind the mountains. Near the mouth of Waipio Valley, on November 17, 1948, five individuals were seen between 3:00 and 5:30 P.M., at a time when the sun set at about five o'clock. Three of these were collected and were found to be females. On one occasion, in August, 1938, two bats flew together back and forth along a lava flow near Kipuka Ki for 30 minutes in the dusk of late evening. Judging from these facts, and considering that several times bats were seen in barren areas up to seven miles from the nearest woods, I should estimate the duration of daily flights to be up to two hours or more.

Flight was generally rather steady, especially when the bat seemed to be going somewhere along a more or less straight course and was not lingering within a small area. When foraging, dips and changes of elevation from five to 50 feet or more were frequent; the pair at Kipuka Ki flew up and down from ground level to an estimated 200 feet in the air. I never heard squeaking noises from the bats flying near me although I could hear the rush of wings. The tail was curved forward under the body in flight. The bats were seen singly most often (May, November, December); twice, two were flying together (August, December); and twice, between three and five were within sight (September, November).

If we assume that the bats were foraging when seen in flight and remaining for a time within a vicinity, then I can record feeding activity from two general types of places: over openings in woods and parkland in the interior areas, and over streams and ponds near the seashore.

Roosting apparently occurred in branches of the screwpine, *Pandanus odoratissimus*, at the seashore. This was told me by a native, Wm. Peleiholani, and confirmed by J. Orr when he collected a bat which fell out of a screwpine at noon, May 31, 1949, at Honaunau. A second roosting place was revealed to be within a mass of exposed tree (*Metrosideros collina*) roots on a steep bank in an open, wooded habitat at 4100 feet elevation when a bat was flushed by P. E. Schulz in July, 1941.

In two female reproductive tracts seen, one in May had two fetuses, one in November none. This indicates that birth occurs in early summer, the same time of year in which young are borne by its close relatives, the red bat and hoary bat, in North America.—PAUL H. BALDWIN, *Museum of Vertebrate Zoology, Berkeley, California.* *Received May 2, 1950.*

UNUSUAL BEHAVIOR AND OCCURRENCE OF A HOARY BAT

On the evening of September 20, 1947, the writer and several other persons were engaged in collecting bats at the base of a precipitous cliff at Carneros Rocks in western Kern County, California. The first bats to make their appearance were western pipistrelles (*Pipistrellus hesperus*) which began flying as soon as the sun was below the crest of a nearby range of hills at 5:55 P.M. A few minutes later Mexican free-tails (*Tadarida mexicana*) were in the air and by 6:30 P.M., which was dusk, the first pallid bats (*Antrozous pallidus*) were observed flying. At precisely the time the first pallid bats appeared Mr. Ian McMillan, who was a member of our party, observed a large, heavy-bodied bat pursuing a small bat about the size of a pipistrelle. The large bat was shot and proved to be a male hoary bat (*Lasiurus cinereus*). It is now no. 9401 in the mammal collection of the California Academy of Sciences.

There is a previous record by Bishop (Jour. Mamm., 28: page 293, 1947 [for correction see Jour. Mamm., 28: page 409, 1947]) of a hoary bat attacking a pipistrelle (*Pipistrellus subflavus*) in New York state. Whether members of this species regularly pursue smaller bats and capture them for food or whether such antagonistic behavior stems from resentment against other competitors for food is conjectural.

Not only was the behavior of the above mentioned hoary bat curious, but its presence in such an environment and at this season of the year deserves comment. Members of this species, during migration, as well as in their summer and winter habitats, are known to

use trees for their daytime retreats. The Carneros Rocks are large sandstone outcrops on the western edge of the most barren part of the San Joaquin Valley. Since the nearest trees are some miles away in the Temblor Range the sudden appearance of this bat at dusk made it seem likely that it had emerged from one of the numerous crevices in the cliff next to which it had been shot.

Obviously, this individual was a south-bound migrant. Although members of this species winter as far south along the Pacific Coast as the Mexican boundary they have not, according to Grinnell (Univ. Calif. Publ. Zool., 17: page 334, 1918) and Dalquest (Murrelet, 24: pages 21—24, 1943) been taken in California farther south than Marin County in September and Santa Cruz County in October.—Robert T. Orr, *California Academy of Sciences, San Francisco, California.* *Received January 7, 1950.*

BATS AS PREY FOR MINK IN KENTUCKY CAVE

Bats are nearly free of predators, for few mammals or birds seemingly have the opportunity or desire to feed on them. However, we have discovered that mink frequenting one bat-inhabited cave feed heavily, if not exclusively, upon the bats therein. Such is the case at Carter Caves, Carter County, Kentucky. The two mink taken in the cave had remains of bats in their stomachs and one taken about one hundred yards outside the cave opening had remains of several bats in the stomach. The bats eaten probably were either *Myotis lucifugus* or *Myotis sodalis*, or both; not the larger *Eptesicus fuscus* or smaller *Pipistrellus subflavus*, both of which are less abundant. This predation must be a seasonal one, for the four species are present, in numbers, only during winter months. We surmise that the mink catch a few bats as they accidentally fall from their ceiling clusters to the floor or stream below. Shifting of bats within a cluster apparently takes place, but must be infrequent. The large number of bats in the cave, perhaps a hundred thousand, makes possible the likelihood of some bats being dislodged at frequent intervals. Some clusters of bats are close enough to the floor of the cave to allow a mink to jump up and grab one or more. This provides a ready, although perhaps not palatable, source of food for this predator. Woodrow Goodpaster and Donald F. Hoffmeister, *6014 Kellogg Ave., Cincinnati, Ohio, and Museum of Natural History, University of Illinois, Urbana.* *Received February 6, 1950.*

NOTES ON THE SEASONAL OCCURRENCE OF RED BATS IN SAN FRANCISCO

In March, 1944, my attention was called to the presence of several red bats (*Lasiurus borealis*) hanging in the foliage of a clump of *Sparmannia africana* in the Strybing Arboretum, several hundred yards from the California Academy of Sciences in Golden Gate Park, San Francisco. The Supervisor of the Arboretum, Mr. Eric Walther, informed me that the bats had been noted there regularly for some months so I decided to check on their presence or absence over a considerable period of time to determine whether or not they remained here throughout the year. During the succeeding five years and nine months (to the end of December, 1949) periodic visits were made to this daytime roost during every month in the year. A summary of these records shows that bats were present from the middle of September to early May. None was observed during the summer. The earliest date of observance in the fall was September 15, 1948, although there is a specimen in the Academy collection (♂ no. 6226) taken in San Francisco on September 7, 1928. The latest date in the spring that individuals of this species were noted was May 9, 1945.

Some years ago Mrs. Hilda Grinnell (Univ. Calif. Publ. Zool., 17: page 326, 1918) concluded, on the basis of museum specimens available, that red bats in California are subject to seasonal movements. Individuals of both sexes were found in the Sonoran zones during the winter, whereas in summer females were taken only in the Lower Sonoran Zone and males in the Upper Sonoran and Transition zones. During the above-mentioned period that observations were made on red bats in Golden Gate Park, no attempts were made to disturb or capture the animals; consequently, the sex of those seen is unknown. However, of five study skins examined (four in the C. A. S. collection, one in the private collection

of Terrence Merkel), taken in or within one mile of San Francisco during the fall and winter months, three are males and two are females. Apparently, therefore, members of both sexes winter here.

The particular clump of Sparmannia where observations were made was in the African section of the arboretum and growing along the southeast margin of some taller shrubs and trees. The clump was about fifteen feet long and the uppermost leaves were about eighteen feet above the ground. The greatest number of bats seen hanging here at any one time was four. However, as each bat seemed to hang in a different place each day (This is contrary to the findings of McClure, Jour. Mamm., 23: page 433, 1942, for summering red bats in Iowa), and these bats closely resembled the numerous dead leaves that seemed always to be present, it was frequently a difficult task to locate a single individual. A roosting bat always clung to a petiole, close to the leaf, so that the body of the animal hung next to the underside of the leaf. The head of a sleeping bat was curled under so that the nose was almost buried in the fur of the breast. Frequently individuals were seen awake, at which times they would scratch and lick their fur and wing membranes. The bats roosted from eight to fifteen feet above the ground.

The preference of members of this species for *Sparmannia africana*—a large-leafed, evergreen, exotic plant that is commonly grown out-of-doors in relatively frost-free parts of central California—is corroborated by two other records. On October 11, 1948, Mr. Terrence Merkel secured a red bat that was hanging from a Sparmannia in San Francisco, and on October 31, 1946, Mrs. Bernadine Henderson presented the Academy with a red bat captured on a plant of this species in her garden in Berkeley, California.

Because of a ruling which requires that the Strybing Arboretum be closed to the public at 4:00 P.M., I was prevented from making any observations on the evening activities of the bats residing there. On the evening of February 8, 1948, however, at my home in Mill Valley, California, I had an excellent opportunity to observe the foraging habits of an individual of this species. At 5:53 P.M., when it was still quite light, I saw a red bat flying over my garden. During the next seven minutes it flew back and forth along a fairly uniform course of 125 yards. The first 75 yards of the course were parallel to a line of Monterey cypress trees and a cypress hedge. The last 50 yards were at right angles to this and parallel to a privet hedge backed by trees of several kinds. For the most part the bat flew from twenty to thirty feet above the ground. Each time it traversed the 125-yard course it dropped three or four times, presumably after flying insects. Sometimes the drop was only a matter of two or three feet while on other occasions it would drop to within four or five feet of the ground. Several times these low drops occurred when the bat was almost directly over me. On such occasions when it was flying so close to me I was surprised not to hear any sound made by its wings. The thought occurred to me that the fairly extensive patches of fur on the antero-ventral parts of the wings might be responsible for muffling the sound. These patches of light-colored fur, incidentally, were quite conspicuous when the bat was flying overhead. In general, I gained the impression that the flight of this individual was very regular. However, it must be remembered that this was mid-winter and flying insects were scarce. Had there been more food on the wing no doubt the flight would have appeared considerably more erratic.—ROBERT T. ORR, *California Academy of Sciences, San Francisco, California.* *Received January 7, 1950.*

AN EXTENSION OF RANGE OF THE HAIRY-TAILED MOLE, *PARASCALOPS BREWERI* (BACHMAN)

During a trapping operation for prairie moles, *Scalopus aquaticus machrinus* (Rafinesque), in Franklin County, Ohio, eight specimens of hairy-tailed moles, *Parascalops breweri* (Bachman), were captured. These eight specimens were of particular interest since *P. breweri* was known to occur very rarely in the glaciated portion of west central Ohio. It has been accepted that the range of *P. breweri* tends to be coincident with the counties of Ohio that lie within the Allegheny Plateau. However, the majority of the counties within

this area were unglaciated. Since Franklin County is well within the glaciated portion of Ohio, it is believed that these trapping records are indicative of an extension of range of *P. breweri*.

According to Jackson (N. Amer. Fauna, no. 38, 1915) the range of the hairy-tailed mole extended into the northeastern counties of Ohio. However, as records were compiled in succeeding years, it was possible to determine the range of this mole throughout eastern and southeastern Ohio (Olive, Ohio Conserv. Bull., 10:4–6, 1946). It was observed that the most frequented habitats within the above-mentioned range were well-drained areas. Many times hairy-tailed moles were found in wooded areas or in woods-edge locations where their runs extended into nearby sodded spaces. It is E. S. Thomas' opinion (personal communication) that *P. breweri* requires "sandy well-drained or over-drained soils, such as are characteristic in the Allegheny Plateau of Ohio." Since the northern part of Franklin County meets these requirements, the problem of migration into this area becomes an interesting one. A probable entry route could have been along the Powell Moraine. This moraine, a formation from the Wisconsin ice sheet, comes in contact with the Allegheny Escarpment in Licking, Morrow, and Richland counties. There is marked continuity of soil types and terrain from the Allegheny Plateau to the Powell Moraine. Thomas suggested further evidence of a homogeneous environment by recording a number of plants which are common to both areas. Some of these are blueberry (*Vaccinium vacillans*), huckleberry (*Gaylussacia baccata*) and mountain sumac (*Rhus copallina*). It is likely, therefore, that the hairy-tailed mole has followed the moraine into this area and has become distributed both north and south from that formation.

Two of the eight Franklin County specimens of *P. breweri* are in the Ohio State Museum, Columbus, Ohio, whereas, a third is in the possession of the author.

Acknowledgment is made of the assistance of Dr. Edward S. Thomas of the Ohio State Museum and Mr. B. Patterson Bole, Jr. of the Cleveland Museum for making their specimen records available.—JOHN R. OLIVE, *Dept. of Zoology, Colorado A and M College, Fort Collins, Colorado.* *Received April 29, 1950.*

THE CINEREOUS SHREW BELOW 6000 FEET IN NORTH CENTRAL COLORADO

The cinereous shrew (*Sorex cinereus cinereus*) is of rather common occurrence in the mountains of Colorado, extending as low as the Transition Life Zone (6000 feet) according to Warren (Mammals of Colorado, 1942). An examination of literature, museum specimens, and personal trapping data suggests that the range of this shrew in the state should also include the higher northeastern plains region.

The U. S. National Museum has one specimen (No. 87544) from a plains meadow west of Loveland (elevation, 5000 feet) which was collected in 1897, and several from unidentified localities near Boulder (approximate elevation, 5400 feet), collected in 1900 and 1902. All are included in Jackson's review of the American long-tailed shrews (N. Amer. Fauna, no. 51). These are old records; but since 1930, twenty-seven have been collected from the vicinity of Fort Collins, a plains community between Denver and Cheyenne, Wyoming. One was caught in a house in the center of town in 1930 (elevation, 5000 feet) and the other twenty-six have been collected between 1947 and 1949 in a cattail marsh and cottonwood river bottom three miles southeast of Fort Collins (elevation, 4900 feet).

The population density in this latter area is relatively high. Of one hundred small mammals trapped in the marsh by J. W. McDowell in 1947–1948, sixteen were shrews; one month of trapping in a quarter-acre weed patch by myself, in the fall of 1949, netted five individuals.

These records should firmly establish the cinereous shrew as a resident below 6000 feet in northeastern Colorado. Representative specimens from the Fort Collins area are now in the mammal collections of Colorado A & M College, the University of Colorado Museum, and the University of Wyoming.—RICHARD G. BEIDLEMAN, *Zoology Department, Colorado A & M College, Fort Collins, Colorado.* *Received January 21, 1950.*

THE BLACK-FOOTED FERRET IN OKLAHOMA

In the past few years little in the way of curatorial work has been done either in the bird or mammal collections in the Zoology Division of the University of Oklahoma Museum. Recently acquired storage space now makes it possible to rework much of this material. In reworking, one specimen of the black-footed ferret, *Mustela nigripes* (Aud. & Bach.) has been discovered. It was taken one mile east of Norman, Cleveland County, on 25 July 1928, by Fred Barkley. The skull is crushed, and the specimen was evidently in poor condition when received, for the flesh of the tail was not removed, and all of its hair has sloughed off. In spite of this the animal was made up into a recognizable skin; the very dark legs and feet, the yellowish fur with dark guard hairs, and the dark facial mask are quite distinct. No measurements were taken, nor any other data than that recorded above. The ferret had not been identified, and was entered in the catalog as No. 8846, "a mammal."

Blair (Amer. Midl. Nat. 22(1):85–133, 1939) apparently was unaware of the existence of this specimen, as the species is not included in his list of the mammals of the state. Its extreme rarity makes this record of special interest, since it extends the known limits of the species east to between the 97th and 98th meridians in Oklahoma.—M. Dale Arvey and Bryan P. Glass, *University of Oklahoma, Norman, and Oklahoma A & M College, Stillwater, Oklahoma. Received February 15, 1950.*

SYNAPTOMYS BOREALIS FROM GLACIER NATIONAL PARK, MONTANA

An adult male of *Synaptomys borealis* was trapped on July 30, 1949, in Glacier National Park. The area trapped was west of the continental divide on the edge of a swampy area on the north side of Camas Creek, three miles east of the park bridge crossing the creek. Some of the species of plants in the immediate vicinity were: Englemann spruce (*Picea englemannii*), timothy (*Phleum pratense*), false hellebore (*Veratrum viride*), alder (*Alnus tenuifolia*), nannyberry (*Eleagnus canadensis*), cow parsnip (*Heracleum lanatum*), horsemint (*Monarda menthaefolia*), yellow monkey flower (*Mimulus guttatus*), and snowberry (*Symphoricarpus albus*). Other mammals caught in the 62 snap traps set on this plot were: three *Microtus pennsylvanicus* and two *Sorex vagrans*. Moose (*Alces americana*) were abundant in the area. This site lies within what Bailey (Wild Animals of Glacier National Park, U.S.D.I., Nat. Park Serv., 1918) considered the Canadian Zone.

In September, 1949, C. D. Haynes assisted me in trapping this immediate area intensively in an attempt to obtain additional specimens of *Synaptomys*. From September 18 to 20 we had about 100 snap traps set in this particular site and we caught 15 *Sorex vagrans*, one *Sorex palustris*, 32 *Microtus pennsylvanicus*, and one *Microtus richardsoni*, but no additional specimens of *Synaptomys*. The specimen was sent to the U. S. National Museum where it was compared with specimens of *Synaptomys borealis borealis* and *S. b. chapmani* from western Canada. The Glacier Park specimen appears closest to *chapmani*, but it has the bullae less inflated, the dorsal pelage darker, and less buff on the hair tips of the underparts. In spite of these differences it seems best to refer the specimen to *chapmani* until more material can be obtained. Although Vernon Bailey collected mammals in Glacier Park on several occasions it is not surprising, due to the elusive nature of this species, that he failed to obtain it. The specimen represents a new record of this species from Glacier National Park and from Montana.—Philip L. Wright, *Department of Zoology, Montana State University, Missoula, Montana. [Collaborator Glacier National Park and Montana State University Biological Station] Received April 25, 1950.*

EXTENSION OF RANGE OF THE ROUND-TAILED MUSKRAT, *NEOFIBER ALLENI*

The round-tailed muskrat, *Neofiber alleni*, was first recorded from Georgia by Francis Harper (Jour. Mamm. 1:65, 1920), from Okefinokee Swamp. On February 8, 1950, the junior author presented three *Neofiber alleni* skulls to the Biological Surveys collection and retained three at the University of Georgia. These specimens were taken from barn owl pellets collected at Woodbine, Camden County, Georgia.

These Woodbine specimens extend the range of *Neofiber alleni* 25 miles eastward in Georgia, toward the Atlantic coast line. In Florida the most northern published coastal record is Titusville, Brevard County (Bailey, N. Amer. Fauna no. 17, p. 79, June 6, 1900) VIOLA S. SCHANTZ AND JAMES H. JENKINS, *U. S. Fish and Wildlife Service, Washington 25, D. C.; and State Game and Fish Commission and School of Forestry, University of Georgia, Athens, Georgia.* *Received March 27, 1950.*

ADDITIONAL RECORDS OF THE JUMPING MOUSE, *ZAPUS HUDSONIUS*, FROM GEORGIA

Petrides (Jour. Mamm., 29: 75–76, 1948) recorded the first specimen of the meadow jumping mouse (*Zapus hudsonius*) from Georgia when, on September 22, 1944, he secured a live female near Athens, Clarke County. Since that time extensive trapping operations have failed to yield further specimens in Georgia though Odum (Jour. Mamm., 30: 179–192, 1949) recorded this species in the Highlands, North Carolina region less than one mile from the Georgia state line. Three additional records of this species have been obtained in Georgia recently.

On July 26, 1949, the writers trapped a male *Zapus hudsonius* about fifteen miles northwest of Gainesville, Hall County, Georgia. The previous afternoon we set out 12 "Museum Special" mouse traps at random in a small 3–4-year-old field containing broomgrass (*Andropogon*), other grasses, and composites. This small field was between a corn field and a thicket along a stream. The runways in the grass were old, and it was evident that the field had been flooded recently, though it was dry at the time of our trapping. The only specimen secured in the traps was the jumping mouse, which was caught by the tail. There was evidence of quite a struggle on the mouse's part since the tail was nearly torn off, and the trap had been dragged about a foot back into the thick grasses. The specimen measured: total length, 207 mm.; tail, 125 mm.; hind foot, 28 mm.; it weighed 14.3 grams. The skin and skull are deposited in the University of Georgia Museum (#535).

Two additional specimens of *Zapus* were secured by predators. The first came from a rattlesnake (*Crotalus h. horridus* x *atricaudatus*) which was killed by members of a University botany class on July 26, 1949, about two miles south of Whitehall in Clarke County. Dr. E. P. Odum discovered that the snake's stomach contained unmistakable remains of a *Zapus*. The skull was not present, but the tail, feet, and some fur were recognizable. The snake, measuring 3 feet 10 inches, was killed in a shrubby ravine under some power lines. Trapping immediately thereafter in this area produced no mammal specimens.

The second predator record came about when a *Zapus* skull was found in a series of barn owl (*Tyto alba pratincola*) pellets collected May 10, 1949, at Bogart, Oconee County, about eight miles west of Athens. This was the only jumping mouse skull found among 233 mammal skulls examined, and is further evidence that *Zapus* is rare in the Piedmont of Georgia. Furthermore, up to the present time predators have been as efficient as mammalogists in collecting *Zapus*.

Apparently the Whitehall, Clarke County, record above is the most southern for *Zapus* in the eastern United States.—JAMES H. JENKINS AND DAVID W. JOHNSTON, *State Game and Fish Commission and School of Forestry, and Dept. of Biology, University of Georgia, Athens, Ga.* *Received February 15, 1950.*

THE ROOF RAT, *RATTUS RATTUS ALEXANDRINUS* (GEOFFROY), IN WEST VIRGINIA

In July, 1949, Wayne Davis, of Morgantown, West Virginia, informed me that both black and roof rats were common in the vicinity of Pleasant Dale, Hampshire County, West Virginia. In view of the fact that there appeared to be no published records of the occurrence of the roof rat in West Virginia, I accompanied a group of students and a staff member of the Oglebay Institute Nature Leader's Training Camp to Pleasant Dale on July 9, 1949, in an effort to collect specimens of the roof rat. Three roof rats and four black rats, *Rattus rattus rattus* (Linnaeus), were secured from a granary on a farm some four miles north of Hanging Rock, Hampshire County, West Virginia.

In this area, the two subspecies exist side by side, and apparently interbreed freely. One individual of each subspecies was killed with a single charge of .22 dust shot.

According to natives, the Norway rat does not occur in the vicinity of Pleasant Dale and Hanging Rock.—ROGER W. BARBOUR, *Oglebay Institute, Wheeling, West Virginia.* *Received February 1, 1950.*

SPIROCERCA FROM THE SNOW LEOPARD

Although *Spirocerca lupi* (Rudolphi, 1809), commonly known as the esophageal worm of dog, has been reported from several species of carnivores living in many warm countries of the world, to our knowledge it has not been reported from the snow leopard (*Panthera uncia* (Schreber)). Two of these rare and expensive mammals received in January, 1949, had been in the collections of the Zoological Society of San Diego for seven days when one of them died suddenly for no apparent reason. Autopsy revealed a large quantity of extravasated blood in the thorax, and further examination showed the thoracic aorta embedded in a partly organized hematoma. Five separate aneurysms were found. The one closest to the aortic arch had ruptured and contained three nematodes, apparently the cause of the aneurysms. Another nematode was removed from the inner wall of the aorta, but was broken in the removal process. These worms have been identified as *Spirocerca lupi*, a species of worm known to penetrate, as larvae, the gastric wall of carnivores. Upon reaching the arteries they migrate, in the walls of the coronary and gastro-epiploic arteries, to the coeliac artery and thence to the upper abdominal and lower thoracic portions of the aorta, reaching the upper thoracic aorta in about three weeks. Here they attach and cause the formation of characteristic nodules. Esophageal and stomach tumors occur in many infected animals, and it is believed that the parasites migrate towards the wall of the esophagus from the aorta through the connective tissues separating them. In the case of this snow leopard, it is possible that the worms were still migrating, as all found were young. The three largest were young eggless females between 15 and 19 mm. in length; the other, apparently a young male, was broken upon removal and could not be measured. No worms were observed in the stomach or esophageal walls, usual abodes for the adults that later reach maturity and reproduce.

Because the worms found were young, and migration takes but a few weeks, speculation permits us to suggest that the infection in this snow leopard was acquired in Calcutta where the animals were kept for two or three months before their flight, via Paris, to San Diego. Little information is available on their history before they reached Calcutta, on their trek from the Himalayas where snow leopards are reported to live at the great elevations of from 7000 to 18,000 feet, more commonly on the Tibetan side. This record adds another victim to the long list of hosts of this heteroxenous parasite.—ARTHUR L. KELLY AND LAWRENCE R. PENNER, *Biological Research Institute of the Zoological Society of San Diego, and the Department of Zoology, University of Connecticut, Storrs.* *Received March 22, 1950.*

SARCOCYSTIS IN THE MOOSE

In a recent note in this Journal (1949, 30:430), A de Vos and A. E. Allin reported what they believed to have been the first record of the fungus *Sarcocystis* from the moose. The cardiac muscle of a sick bull moose, estimated to be between four and six years old, which was shot near Shebandowan, Ontario, was infected. They suggested that abnormal behavior exhibited by the moose may have been the result of this and other kinds of parasites which were found to be present. We wish to record another instance of *Sarcocystis* in the moose.

The Zoological Society of San Diego received a young male moose from the Calgary Zoological Society on September 19, 1947. According to Tom Baines, Curator of the Calgary Zoo, it was born in June, 1946, near Dawson Creek, British Columbia. "Calgary" was captured after he and his mother were attacked by a grizzly when crossing the Kiskatinaw River near Dawson. The mother was killed by the bear, the grizzly was shot, and "Calgary" was dragged ashore. He lived in and around Dawson for about three months. His habit of invading stores (he was fond of oranges) and dwelling houses caused him to be acquired

by the Calgary Zoo. In San Diego, on October 1, 1948, "Calgary" was found dead in his pen. Autopsy showed marked endocardial hemmorrhage with no reason for it. There was no evidence of a struggle, and he was in good condition. There were no ticks on him, nor internally, any hydatid cysts. Heart sections, however, contained small oval patches which have been identified as *Sarcocystis*. Whether this fungus organism, long thought to be a sporozoan, was the cause of death, can only be speculative.—Arthur L. Kelly, Lawrence R. Penner, and Rawson J. Pickard, *Biological Research Institute of the Zoological Society of San Diego, and the Department of Zoology, University of Connecticut, Storrs.* *Received March 22, 1950.*

BREEDING OF THREE-YEAR-OLD FEMALES IN THE JACKSON HOLE WILDLIFE PARK BUFFALO HERD

A review of the literature regarding the habits of the buffalo, *Bison bison*, reveals that there is an extreme lack of records on the breeding age of the females. It has been the standing opinion of observers of the Yellowstone National Park buffalo herd that cows do not bear young until they reach the age of four years. Records of other herds as well fail to indicate the breeding age of the females. The following data has been organized from the records of the Jackson Hole Wildlife Park, located at Moran, Wyoming.

In January, 1948, the Wildlife Park acquired a small herd from the large Yellowstone herd. In the original group obtained there were fourteen females. In the spring of 1948, three of these were yearlings, seven were two-year-olds, one was a three-year-old, and three were four-year-olds. The ages of all were certain since they were tagged as calves at the time of the first inoculation against brucellosis.

In the spring of 1948 the only cows of the Wildlife Park herd which gave birth to calves were the four-year-olds, each of which produced a calf. These were thought to be their first calves, but there is no way of being certain. However, they did not have calves with them at the time of their capture in the corrals at the Buffalo Ranch, Yellowstone National Park, in January of 1948.

In the spring of 1949, eight calves were born to the herd. Of these, three were born to five-year-olds, each of which produced a calf in 1948, one to a four-year-old, certainly her first calf, and four to three-year-olds. Three other three-year-olds did not produce calves in 1949. The largest bull, three and a half years old at the time of breeding season, probably sired all of the 1949 calves, since two of the other three males in the herd were one and a half and one was two and a half years old at the time.—Norman C. Negus, *Department of Zoology, Miami University, Oxford, Ohio.* *Received February 15, 1950.*

BIGHORN EWE ASSOCIATES WITH CATTLE ON KOFA GAME RANGE, ARIZONA

It has been rather frequently recorded that bighorn sheep (*Ovis canadensis*) have associated in more or less degree with domestic sheep. A review of the available literature, however, indicates that an association of a bighorn sheep and cattle may be worthy of note.

While on patrol in the Kofa Game Range of Yuma County, Arizona, on November 10, 1949, we came upon a ewe bighorn in company with three white-faced range cows and two calves. The location, which is a few miles removed from typical desert sheep country, is about one and one-fourth miles from Jasper Spring, a watering place developed for cattle. When first seen, the animals were slowly traveling in a mesquite-filled arroyo toward the broken foothills that form the base of the northern slopes of the jagged peaks of the Kofa Mountains. We trailed the group for several hundred yards. When we caught sight of them a second time all were together. At our closer approach they bolted into the brush, led by the bighorn.

On September 5, 1948, the junior author noted a young ewe bighorn leaving Jasper Spring in company with six cattle, three of which plodded ahead while the rest of the group trailed about sixty feet behind her. It is possible that these two observations are of the same ewe, although we have no proof. Desert mule deer also are known to water at this spring, particularly in dry periods when most of the waterholes in the nearby mountains become dry

before being replenished by the rains of July or August.—Arthur F. Halloran and Willard E. Blanchard, *Fish and Wildlife Service, Yuma, Arizona. Received January 20, 1950.*

CRYPTORCHID ELK (*CERVUS CANADENSIS*) IN THE BLUE MOUNTAINS OF WASHINGTON

On 12 November 1949 I killed an antler-less bull elk on the Lick Fork of Asotin Creek, Asotin County, Washington. It was presumed to be a female and was shot under a special elk permit. This animal had a functional male urethral opening far forward on the mid-ventral line of the belly, but there was no indication of a scrotum or vagina. A single testis was found attached to the inside of the belly wall, but the other one could easily have been overlooked in the rush of dressing and packing out the meat under very adverse conditions. I have compared this testis with one from an elk calf about six months old and the two are about equal in size.

This animal probably weighed about 500 pounds on the hoof and was very fat. According to Dr. H. K. Buechner, it was 4½ years old as indicated by the teeth. An examination of the skull shows that it had never grown antlers, since no pedicels are present on the frontal bones.

There seems to be no readily available information on cryptorchism in the elk and it would be interesting to know something of the frequency of occurrence of this abnormality. Probably such animals are pretty much of a total loss to game management since they obviously do not reproduce and would seldom be shot except in areas where the taking of cow elk is permitted. Several hunters with whom I discussed this matter knew of the condition and referred to such animals as "muley" bulls.—George E. Hudson, *Department of Zoology, State College of Washington, Pullman. Received March 11, 1950.*

CLEANING MAMMAL SKELETONS WITH MEAL WORMS

Mammalogists have long used dermestid beetles for cleaning small skulls or skeletons. Recently, Hooper has enumerated the advantages of dermestid cleaning as compared with cooking and hand cleaning (Jour. Mamm., 31: 100–102, 1950). There remains, however, a major objection to the use of dermestids—the possibility that the beetles may spread and infest a valuable skin collection. As Hooper notes, dermestid colonies must be kept in a separate room, apart from research collections; some institutions insist upon separate buildings.

We wish to call attention to the fact that meal worms (tenebrionid beetle larvae) will clean small skulls, and have certain advantages over dermestids. Meal worms, widely used as food for various captive creatures, are sold by pet shops and animal dealers throughout the country. Easily kept in almost any sort of container, they require little care or attention. Leaflets on raising meal worms may readily be obtained from many sources. Most important, meal worms will not spread to infest a skin collection.

We keep tenebrionids in cans filled with bran. Chunks of apple or potato are added to provide moisture and a varied diet. Skulls to be cleaned are simply placed in the can and barely covered with bran. The meal worms reduce the flesh to powdery frass, leaving behind bone and connecting ligaments. In this way we have prepared skulls of marmosets and larger monkeys, wildcats, and raccoons.

Our experience with meal worms has not been extensive, and further experimentation is to be desired. Certainly, however, the use of tenebrionids merits consideration by mammalogists.—E. Ross Allen and Wilfred T. Neill, *The Reptile Institute, Silver Springs, Florida. Received March 17, 1950.*

NOTES ON THE DISTRIBUTION OF SOME ARCTIC MAMMALS

Mammals, representing 23 species, were examined in 1949 and early 1950 during the course of host-parasite studies made in northern Alaska. Since this work was done in a region where the fauna is little known, information obtained on the distribution of mammals is presented here. Records on three additional species are included, although actual specimens were not obtained.

The taxonomic work was done by the writer at the U. S. National Museum and the National Museum of Canada. This opportunity is taken to express appreciation of the generous co-operation of Dr. Remington Kellogg, Dr. David H. Johnson, and Dr. Henry W. Setzer, of the U. S. National Museum, and Dr. Rudolph M. Anderson, of the Canadian National Museum, during the course of this work. All specimens upon which this report is based have been deposited in the U. S. National Museum and the Canadian National Museum.

Most of the mammals considered in this report were collected in the vicinity of Tolugak Lake (lat. 68° 24′ N., long. 151° 26′ W.), which is situated near the head of the Anaktuvuk River at the north edge of the Brooks Range. Specimens were obtained from as much as 40 miles south of Tolugak Lake, in the valleys of the Anaktuvuk and John rivers. A small series of mammals was also collected near Umiat (lat. 69° 23′ N., long. 152° 10′ W.), on the Colville River about 80 miles north of Tolugak Lake. Umiat is near the north edge of the Arctic Plateau.

The mammals considered are listed separately below. More nearly complete details concerning ecology, reproduction, and other phases of the bionomics of these mammals will be presented in a future publication.

Sorex o. obscurus Merriam.—Twenty-seven shrews of this species were collected near Tolugak Lake, where they occurred in low, moist areas.

Sorex cinereus ugyunak Anderson.—A single shrew referable to this form was collected at Tolugak Lake in the autumn of 1949. An alcohol-preserved specimen, collected at Umiat in 1948, was given to the writer by Mr. Vladimir Walters, Dept. of Zoology, New York University.

Ursus richardsoni Swainson ssp.—An undetermined race of grizzly bear was common in the vicinity of Tolugak Lake, from where a good series of skulls was obtained. Material was also examined from other localities, including Oomalik and south of Wainwright. The skull of a specimen killed by Mr. Robert Brower on the Alaktak River, near Admiralty Bay, was obtained. Mr. Lloyd Spetzman, Dept. of Botany, University of Minnesota, kindly gave the writer the skull of a young animal killed five miles west of Shublick Springs, in the valley of the Canning River. These bears are being studied further by Dr. R. M. Anderson, in the hope that more can be learned concerning their relationships.

Vulpes fulva alascensis Merriam.—The red fox was common everywhere observations were made. Cross and silver color phases were observed. A series of skulls from animals taken on the upper John River was preserved.

Alopex lagopus innuitus (Merriam).—The arctic fox is irregularly taken as far south as the Brooks Range. At least two specimens were taken along the Killik River, near the mouth of Easter Creek, in 1947. This information has been obtained from the Eskimos, and no specimens were obtained.

Canis lupus tundrarum Miller.—Wolves were widely distributed over the region, and many are killed each year by the Eskimos. Seventeen skulls were preserved, from animals taken in the Anaktuvuk and John River valleys.

Martes americana actuosa (Osgood).—A single marten was trapped by an Eskimo on Hunt Fork, a tributary of the John River, during the winter of 1949. This animal is very rare so far north, and the Eskimos knew of no other marten ever having been caught in this region. The skin and skull of this animal were secured.

Mustela erminea arctica (Merriam).—The ermine was widely distributed, and specimens were secured from Tolugak Lake and upper John River. A specimen was found dead at Umiat during the summer of 1949, but only the skull could be salvaged.

Mustela r. rixosa (Bangs).—Two least weasels were obtained, both from Tolugak Lake. Tracks of this animal are occasionally seen during the winter, but it is rarely collected or observed in this region. One specimen is in summer and one in winter pelage.

Mustela vison, probably **M. vison ingens** (Osgood).—Although no specimens of mink were secured, sight records by the Eskimos indicate that it does occur very rarely in this region. Trappers with long experience in the region say that the mink is not a resident, but may occasionally appear during the summer months. There is one definite summer record for Chandler Lake.

Gulo l. luscus (L.).—The wolverine is taken each year in fair numbers by the Eskimos. Three skulls from upper John River and two skulls from Anaktuvuk Pass were preserved.

Lutra canadensis (Schreber) ssp.—No specimen of otter was secured, but there have been sight records in this region. Mr. A. L. Bowsher, U. S. Geological Survey, observed an otter during June, 1949, on Kanayut Lake, about fifteen miles northeast of Tolugak Lake. They have been rarely seen by the Eskimos.

Lynx c. canadensis Kerr.—The lynx occurs below timber line along the John River, and in some years may greatly extend its range northward. Only one specimen, taken at the mouth of Poblatook Creek, a tributary of the John River, was preserved. In early 1950, lynx tracks were rather abundant along Hunt Fork and north along John River to the limit of the spruce timber.

Lepus americanus dalli Merriam.—Although only winter specimens have been thus far obtained, hares from the upper John River have been referred to this form. They often occur among the willows in the river bottom for some distance north of the last spruce timber. Eight specimens were preserved.

Marmota caligata broweri Hall and Gilmore.—This form of the hoary marmot was locally common around Tolugak Lake. Two skins and four skulls, taken about ten miles south of Tolugak Lake, were preserved.

Citellus parryi barrowensis (Merriam).—The ground squirrel of this region has been provisionally assigned to this form until larger series of other subspecies, showing seasonal variations, can be obtained. Some of these squirrels were collected at Umiat, and a small series from near Tolugak Lake was preserved.

Tamiasciurus hudsonicus preblei Howell.—Red squirrels have been observed north to the limit of the spruce timber in the John River valley. Four specimens, from Hunt Fork and John River, were preserved.

Lemmus trimucronatus alascensis Merriam.—A small series of brown lemmings was secured at Tolugak Lake. A single immature specimen was collected at Umiat. The skull of an adult animal was removed from the stomach of a rough-legged hawk which was nesting on a bluff of the Colville River near the same locality.

Dicrostonyx groenlandicus rubricatus (Richardson).—Six collared lemmings were taken at Tolugak Lake, but were uncommon during 1949 and the winter of 1950.

Clethrionomys rutilus dawsoni (Merriam).—More than twenty specimens of this red-backed vole were collected at Tolugak Lake, and a smaller series at Umiat. This vole was not differentiated by the Eskimos, and no further information was obtained from them.

Microtus oeconomus macfarlani Merriam.—Tundra voles were common at Tolugak Lake and at Umiat, and small series were preserved from both localities.

Microtus miurus paneaki Rausch.—More than 100 specimens of this vole were taken at Tolugak Lake and vicinity, and a small series was collected at Umiat. These voles have been considered to represent a distinct race (Rausch, Jour. Wash. Acad. Sci., 40: 135, 1950).

Erethizon dorsatum myops Merriam.—Porcupines have been observed irregularly to the limits of spruce timber along John River. A single specimen was secured. In 1946 a porcupine was killed by the Eskimos at Chandler Lake. Some years, however, they have greatly extended their range northward.

Alces americana gigas Miller.—Although well established and common around Umiat, the moose occurs irregularly in the Anaktuvuk and John River valleys. A single skull, from an animal killed just south of Tolugak Lake, was preserved.

Rangifer arcticus stonei Allen.—Caribou migrate nearly every year through the Anaktuvuk and John River valleys, and at times are extremely abundant. Five skulls, from animals killed at Tolugak Lake, have been deposited in the National Museum.

Ovis d. dalli Nelson.—Dall sheep are commonly seen in the mountains around Tolugak Lake and along the Anatuvuk and John rivers. Two skulls from Tolugak Lake were preserved.—Robert Rausch, *U. S. Public Health Service, Anchorage, Alaska.* *Received February 23, 1950.*

REVIEWS

Grange, Wallace Byron. THE WAY TO GAME ABUNDANCE. New York and London: Charles Scribner's Sons. 8 vo., pp. xxiii + 365, pls. 22, map 1. November, 1949. Cloth, $6.00.

So many of the recent books on game management or conservation tend to repetitious jargon or hackneyed babble that it is really refreshing to one's mind to see a book that shows originality of thought and presentation such as Grange's THE WAY TO GAME ABUNDANCE. It is not a book that one can sit down and digest in one evening, nor in one reading, though it is as clearly and simply written as matter of such import can well be. We are told on the wrapper that it is "of interest to all naturalists, sportsmen, and nature lovers." It should be. One might be excused, however, for having some doubt as to its being of interest, or even understandable, to the general run-of-the-mill sportsman, though the more serious sportsman should find it interesting and profitable reading. Naturalists and nature lovers will find it educational and enjoyable. Biologists, and especially mammalogists, will find it stimulating and useful. Ecologists, conservationists, and wildlifers will find it suggestive and indispensable. The volume is provided with a table of contents and an index.

The book is divided into four parts followed by a concise four-page conclusion. Part One (52 pages) entitled "The Pattern of Life," the biological and environmental background, delves into such subjects as patterns of environmental adjustment, the mathematics of abundance, the daily and annual activity cycle, home range and habitat, theory of production, and theory of disease. Concise analysis and classification often accompany treatment of broad subjects, thus, "Analysis of the *annual food cycle* of northern Deer, then, shows the following course of events:

1. A summer system of plenty, with no food shortage, with expansion *of range*, and during which fawns are born. Food dependence is upon *growing* plants.

2. A fall season of plenty with *concentration* at areas which offer special fruit, mast, or grain and crop supplies. Food dependence is partly upon growing plants, partly upon *stored* foods, such as acorns.

3. A late autumn or early winter time of browsing in which *favorite* browse plants are taken in quantity. Food dependence is now entirely upon *stored* foods. Range *concentration* necessarily occurs.

4. A late winter period in which most preferred foods have been consumed, with dependence upon less desirable browse. Circumstance may make this *a pinch period* or even a starvation period.

5. An early spring food period during which Deer glean sustenance from freshly exposed remnants of food missed during autumn and winter, merging into

6. The late spring period when sustenance is again derived from *growing* plants" (p. 23).

Part Two, "Plant and Animal Successions" (61 pages) has to do with the nature and inevitability of habitat change and enlarges on the game range and primeval wilderness and succession wilderness, with an example of succession in a Lakes States pinery. Here also is an elucidating chapter on the impacts of civilization.

Part Three, "Population Cycles" (94 pages) answers the question "why abundance is necessarily cyclic?" and covers mechanisms of population response to habitat changes. It is in this chapter that Grange displays much originality and propounds several theories based on his researches for more than a quarter of a century, chiefly on studies of the snowshoe rabbit, but also covering other species as, for example, the cottontail, muskrat, and white-tailed deer among mammals, and the bobwhite quail and ruffed grouse among birds. Grange reviews various explanation theories of game cycles. He states several laws as the Law of Ideal Succession State: In any plant succession to which an animal species belongs by racial affinity, there usually is only one succession stage (or combination of several) in the entire sequence from denudation to climax which will support *real abundance* of that animal (p. 135). The Law of Natural Resources—Density: *The density of abundance will be in rather accurate ratio to the combined available resources of any given land unit within the abundance area* (p. 135). Colonization-Dispersal: Whenever a natural propagation area is

in existence (when the habitat is at maximum abundance stage), and in ratio to the abundance density achieved, *the animal population attempts to expand in space; to colonize all reachable habitats suited to the species, marginal for the species, or even unfavorable to it.* It produces an *exportable surplus* of individuals (p. 136). Grange in general considers game cycles as dependent primarily on weather cycles. "It is evident that the weather cycle forms the base of the whole cyclic pyramid among plant and animal populations. . . . . The most basic cause of animal cycles, in fact, is the interacting force of climatic and plant succession cycles (p. 193). And again, "The Snowshoe Rabbit cycle is not the cycle of a Rabbit but the cycle of earth, moon, sun, weather, soil, fungus, bacteria, Pine Mouse, Squirrel, Owl, Lynx, and all other forces of the cosmos effective upon the habitat" (p. 197).

Part Four, "The Technology of Game Increase" (138 pages), considers the tools, methods, and principles of control by man. This part in itself is a treatise on methods of game management. It gleans the best from approved methods of others and intercalates it with the originality of the author and the richness gained from his research and experience. Grange discusses sanely and impartially such controversial subjects as controlled burning for game, forest cuttings, food strips, winter feeding, grazing, aquatic habitats, refuges, restocking, predator control, legislation and law enforcement, and the management opportunity.—HARTLEY H. T. JACKSON.

Carruthers, Douglas. BEYOND THE CASPIAN. A NATURALIST IN CENTRAL ASIA. Edinburgh and London: Oliver and Boyd. xx + 290, 22 pl., 2 fig., 1 map, 1949. Price 22/6 net.

More than 40 years ago Douglas Carruthers, feeling the lure of the mountains and steppes lying near the center of Asia, began there a series of notable explorations. To this day there is probably no finer or more comprehensive publication in English on the physiography and wild life of that fascinating region than his UNKNOWN MONGOLIA (1913, 2 vols.). In THE GUN AT HOME AND ABROAD (1915) he contributed several authoritative chapters on the big game found from Asia Minor to Mongolia and Siberia. His ARABIAN ADVENTURE (1935) provides at first hand most of what we know about the life of the Arabian oryx. These several works constituted some of the most highly prized and most frequently quoted source material for my EXTINCT AND VANISHING MAMMALS OF THE OLD WORLD (1945).

While UNKNOWN MONGOLIA deals mainly with the Altai region and Dzungaria, the present volume carries the reader farther south, from the steppe country about Bukhara and Samarkand to the lofty Tien Shan range. The author was primarily in quest of mammals and birds for the British Museum; among his specimens of the former, five proved to be new to science. His field studies on the wild sheep of Central Asia have placed him in the forefront of authorities on that subject. His adventures and hardships in seeking the animals in their remote haunts, as related here, are of absorbing interest to the mammalogist.

There are also glimpses of wondrous monuments in historic Samarkand, of primitive Uzbeg shepherds in the Kizil Kum, of nomad Kirghiz in the Tien Shan, and of pheasants and many other birds of steppe, valley, and mountain. In the author's own words, his "tale is of the veritable wilderness, and of the 'herds of Pan,' of things which change not, nor are subject to the caprice of Man."

BEYOND THE CASPIAN is the product of a distinguished yet unassuming naturalist—a straightforward, refreshing, and thoroughly enjoyable volume, the like of which is all too rarely encountered. An appendix gives a synopsis of the various classifications of all the Old World wild sheep of the genus *Ovis*. A bibliography of 17 pages, a full index, and a map are useful features of the book.—FRANCIS HARPER.

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THIRTIETH ANNUAL MEETING

THIRTIETH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

The thirtieth annual meeting of the American Society of Mammalogists was held at Mammoth Hot Springs, Yellowstone National Park, Wyoming, June 25 to 28, 1950. Meetings were held in the Government Canteen Building with headquarters at the Mammoth Springs Hotel. A record number of 143 members registered, and, in addition, approximately 40 guests, including wives and children, were in attendance.

The local committee on arrangements consisted of: Victor H. Cahalane, *Chairman*, Lowell Adams, David de L. Condon, Ian McT. Cowan, Paul D. Dalke, Stephen D. Durrant, Reed W. Fautin, C. Lynn Hayward, William L. Jellison, and Philip L. Wright.

PROGRAM

SUNDAY, JUNE 25

8:00 P.M.

Meeting of the Directors, Conference Room, Government Barracks Building

and

Motion Pictures

Various aspects of the behavior of the golden hamster. R. Elizabeth Horner and Roberdeau Callery, *Smith College, Mass.*

The natural history of Oregon. Kenneth Gordon, *Oregon State College, Corvallis.*

Birds, beasts, and the rainbow. E. R. Kalmbach, *Fish and Wildlife Service, Denver.*

MONDAY, JUNE 26

8:30 A.M.

Registration

9:30 A.M.

Welcome. Edmund B. Rogers, *Superintendent, Yellowstone National Park.*

Response. Tracy I. Storer, *President, American Society of Mammalogists.*

1. Yellowstone National Park. David de L. Condon, *Yellowstone National Park.*
2. The mammals of Wyoming: a progress report. Rollin H. Baker, *Museum of Natural History, University of Kansas.*
3. Problems of social behavior in wapiti of Jackson Hole. Margaret Altmann, *Jackson Hole Wildlife Park, Moran, Wyo.*
4. A program for restoring extirpated mammals in the National Park System. Victor H. Cahalane, *National Park Service, Washington.*
5. Status of mountain goats in South Dakota. Walter O. Hanson, *Greybull, Wyo.*

2:00 P.M.

6. American weasels. E. R. Hall, *Museum of Natural History, University of Kansas.*
7. Intergradation between *Martes americana* and *M. caurina* in western Montana. Philip L. Wright, *Montana State University.*
8. The post-glacial dispersal of moose in North America. Randolph L. Peterson, *Royal Ontario Museum, Toronto.*
9. Disease in relation to winter mortality of deer in New York. E. L. Cheatum, *U. S. Fish and Wildlife Service, University of Montana.*
10. Palpation and the progress of rut in porcupines. Albert R. Shadle, *Biology Department, University of Buffalo*

11. Overflow of marten and fisher from wildlife refuges. Antoon de Vos, *Department of Lands and Forests, Ontario.*
12. A review of evidence regarding the age of baleen whales. Gordon C. Pike, *Pacific Biological Station, Nanaimo, B. C.*
13. Plasmacytosis in the bovine udder at the time of colostrum secretion. Berry Campbell, *Department of Anatomy, University of Minnesota. Read by title.*
14. Life history and behavior of the chipmunk, *Eutamias amoenus affinis* (Allen). Harold E. Broadbooks, *Univ. of Arizona.*

6:15 P.M.

Wildlife Search Caravan

Members of the Society joined a caravan under the guidance of the park naturalist and were taken out over the roadsides in the evening to locate wapiti, pronghorns, moose, and other wildlife.

TUESDAY, JUNE 27

8:30 A.M.

15. Pelage color mutations in a small, partially isolated population of *Geomys breviceps.* W. H. McCarley, *Department of Zoology, University of Texas.*
16. The autumnal molts of the meadow vole, *Microtus pennsylvanicus drummondii,* in Wisconsin. W. A. Fuller, *Department of Wildlife Management, University of Wisconsin.*
17. Quantitative studies of small mammals in relation to ponderosa pine regeneration in northwestern Montana. Lowell Adams, Arthur L. Roe, and A. E. Squillace, *Fish and Wildlife Service, Montana.*
18. Some aspects of the Alaskan predator control program. Ralph S. Palmer, *New York State Museum, Albany.*

Group Photograph

10:00 A.M.

Annual Business Meeting

Election of Officers

2:00 P.M.

Symposium on Dynamics of Mammalian Populations

L. R. Dice, *Chairman,* University of Michigan

19. Relation of population structure to population forces. David E. Davis, *The Johns Hopkins University.*
20. Dispersal and inbreeding. Walter E. Howard, *University of California, Davis.*
21. Local variations of abundance within populations. W. Frank Blair, *Department of Zoology and Physiology, University of Texas.*
22. Effects of social behavior. John B. Calhoun, *Hamilton Behavior Station, Maine.*
23. Effects of intra- and interspecific competition. John T. Emlen, *Department of Zoology, University of Wisconsin.*
24. Mechanisms that regulate populations. Francis C. Evans, *Inst. Human Biology, University of Michigan.*

7:00 P.M.

Annual Dinner

(Mammoth Springs Hotel)

Following the Elk to New Zealand, Olaus Murie

(Motion Pictures and Kodachrome Slides)

Government Canteen Building

WEDNESDAY, JUNE 28

8:30 A.M.

25. *Microtus* abundance in Michigan, 1947–50, as indicated by a field survey of signs. Don W. Hayne, *Michigan Agr. Exp. Station.*
26. The use of potential and actual populations to calibrate environmental resistance. George H. Kelker, *Utah State Agric. College.*
27. The yearly range of a migratory herd of mule deer. Thane Riney, *University of California.*
28. Haplomycosis in Montana rabbits, rodents, and carnivores. William L. Jellison, *U. S. Public Health Service, Montana.*
29. A comparative study of the male accessory genital glands of *Neürotrichus*. W. Robert Eadie, *Cornell University.*
30. The adreno-pituitary system and population cycles in mammals. John H. Christian, *Wyeth Institute of Applied Biochemistry, Philadelphia. Read by title.*
31. Status of the manatee in the Everglades National Park. Joseph C. Moore, *Everglades National Park, Florida. Read by Victor H. Cahalane.*
32. Social organization of dog packs running wild in a southern township. Margaret Altmann, *Jackson Hole Wildlife Park.*
33. Yellowstone coyote migration. E. R. Kalmbach and Weldon B. Robinson, *U. S. Wildlife Research Laboratory, Colorado.*
34. The lacteal dentition of some North American bats. W. J. Hamilton, Jr., *Cornell University.*
35. Habits of the lump-nosed bat (*Corynorhinus rafinesquii*) at nursery colonies in central California. Mary Koford, *Museum of Vertebrate Zoology, Berkeley, California.*
36. Thermoregulation in bats. William G. Reeder, *University of California, Los Angeles.*
37. The nutria in Texas. George A. Petrides, *Texas Coop. Wildlife Unit.*

2:00 P.M.

Final Business Meeting of Society

Scientific program resumed after the business meeting

38. Speciation in rodents of the Colorado River drainage of eastern Utah. Keith R. Kelson, *Museum of Natural History, University of Kansas.*
39. A problem in *Reithrodontomys*. E. T. Hooper, *Museum of Zoology, University of Michigan.*
40. A study of age classes, reproduction, and sex ratios of beaver in Wyoming. Dale J. Osborn, *Department of Zoology and Physiology, University of Wyoming. Read by title.*
41. Mule deer in Nebraska National Forest. Levi L. Mohler, John H. Wampole, and Edson Fichter, *Nebraska Game, Forestation, and Parks Commission, Lincoln.*
42. Chemistry as an important tool in wildlife mammal management. Luther L. Baumgartner, *B. F. Goodrich Co., Yonkers, N. Y. Read by title.*

7:30 P.M.

43. Movements of Yellowstone elk as shown by tagging studies. Walter H. Kittams, *Yellowstone National Park.*
44. Censusing elk by airplane in the Blue Mountains of Washington. Helmut K. Buechner, Irven O. Buss, and Homer F. Bryan, *Department of Zoology, Washington State College.*

45. The rabbits of Kansas. E. Lendell Cockrum, *Museum of Natural History, University of Kansas.*
46. Predator-prey relationships of a mammal population in western Texas. Jack A. Herrmann, *Department of Zoology, University of Texas.*
47. Tooth replacement in *Antrozous*. Robert T. Orr, *California Academy of Sciences, San Francisco.*
48. Notes on bats in the Mexican state of Morelos. William B. Davis, *Texas A. and M. College. Read by title.*
49. Variability in the Bavarian redbacked mouse, *Cleithrionomys glareolus* Schreber. W. Prychodko, *Detroit, Michigan. Read by title.*

BUSINESS MEETINGS

At the meeting of the Board of Directors on June 25, Harold E. Anthony was reelected a Trustee for the period 1950–1953 and William H. Burt was reelected Editor.

The annual business meeting on June 27 was attended by 84 members and was presided over by President Tracy I. Storer. The following officers were reelected: Tracy I. Storer, President; Lee R. Dice and William J. Hamilton, Jr., Vice-Presidents; Robert T. Orr, Recording Secretary; Donald F. Hoffmeister, Corresponding Secretary; and Viola S. Schantz, Treasurer. Directors for the term 1950–1952 were elected as follows: Randolph L. Peterson, William B. Davis, Colin C. Sanborn, Ralph S. Palmer, and Stephen D. Durrant. The Society decided to continue its membership in the International Union for the Protection of Nature and its affiliation in the American Institute of Biological Sciences. Harold E. Anthony, Trustee, sent a most encouraging letter regarding the financial status of the Society. Dr. Anthony's careful and wise attention to the finances of the Society drew a unanimous vote of appreciation from the business meeting.

It is with deep regret that the Society learned of the deaths of 18 members during 1949, two of whom were Life (†) Members and six of whom were Charter (*) Members: W. Reid Blair, *Benjamin F. Bolt, William B. Cabot, *Herbert M. W. Haven, *Arthur H. Helme, Victor E. Jones, †William S. Ladd, *Edward A. McIlhenny, Chase S. Osborn, John Pearce, Gayle Pickwell, Walter B. Sheppard, Guy C. Shortridge, Frank Thone, *Charles T. Vorhies, and *†F. C. Walcott.

There were 169 nominees for membership during 1949, 27 resignations, and 17 members were dropped from the roles for being in arrears in dues for three years. The year 1949 produced the largest number of annual members, the largest number of subscribers, the largest mailing of the Journal, and the largest number of new members obtained in any one year in the history of the Society. New subscriptions to the Society are not keeping pace with new memberships and the number of Life Members has decreased to 49 whereas at one time the Society had 62 Life Members. A large percentage (one out of three) of the members and subscribers pay their annual dues after the affixed deadline. This **negligence is costly** to the Society and increases the secretarial work many fold.

It was recommended by the Board of Directors, at a special session on June 28, that Article VIII, Sec. 2, of the By-laws, as now amended be further amended so that payment of $25 in each of four consecutive years can be made towards a life membership rather than $100 in a single payment, and the payment of further annual dues would not be necessary during this 4-year period.

The reports of the Corresponding Secretary, Recording Secretary, Treasurer, Trustees, and special committee on the Index were read and accepted. Reports of the following standing committees were read and accepted: Conservation of Land Mammals, Bibliography, Marine Mammals, Economic Mammalogy, Nomenclature, Membership, and Editorial. Reports of representatives to other societies were presented.

The site of the 1951 annual meeting was determined by preferential voting with the following results: Chicago (Natural History Museum), 210; University of Kansas, Lawrence, 202; Charleston, South Carolina, 192; Boston, 139. The vote also indicated that the members present desired, by over a 12 to 1 majority, to meet in 1952 in a National Park, State Park, or some site "in the country."

The Corresponding Secretary submitted the following summary of membership, subscriptions, and mailing for the year ending December 31, 1949.

SUMMARY OF MEMBERSHIPS AND SUBSCRIPTIONS FOR 1948 AND 1949

MEMBERSHIP	1948		1949	
Changes since preceding annual report				
Nominees		161		169
Resignations	20		27	
Deaths reported	20		16	
Members dropped (delinquent)	26		18	
" " (previously inactive for duration)	42		—	
	—		—	
Total		108		61
Net Change		+53		+108
Status as of December 31				
Honory members	3		3	
Life members	50		49	
Annual members	1071		1180	
Total membership		1124		1232
SUBSCRIPTION				
Changes since preceding report				
New subscriptions	81		44	
Subscriptions cancelled	20		31	
	—		—	
Net change		+61		+13
Status as of December 31				
Total paid subscriptions		370		383
MAILING LIST				
Total membership	1124		1232	
Members not receiving Journal	126		129	
	—		—	
Total members receiving Journal		998		1103
Total paid subscriptions		370		383
		—		—
Total mailing list		1368		1486
Net change from preceding year		+93		+118

RESOLUTIONS

The following resolutions were passed:

Be it resolved: That the American Society of Mammalogists at the thirtieth annual stated meeting extends to the National Park Service and to the Local Committee on arrangements its thanks and hearty appreciation for providing facilities and entertainment whch have contributed so largely to the success of the meetings and to the enjoyment of the attending members.

Be it resolved: That the American Society of Mammalogists urges that the Canadian Government not undertake the introduction of reindeer into Ungava. Before any introduction even is seriously considered, those persons involved in any planning are urged to make a thorough study beforehand of the problems of integrating lichen ecology, reindeer biology, and native culture—serious problems that have not been solved to date on any workable scale on the North American continent. It would be particularly deplorable if an introduction, to aid the natives, led to early successes and high hopes, then eventual failure.

Be it resolved: That the American Society of Mammalogists urges that the states of Michigan, Minnesota, and Wisconsin outlaw the practice of den hunting for the purpose of

destroying young timber wolves. It is recognized that the eastern timber wolf is a vanishing mammal and grave concern is manifest toward taking steps to conserve the remnant population on its much reduced range. Outlawing the practice of den hunting for the purpose of destroying the young would constitute an important contribution to the problem of implementing the idea of preserving this remnant population.

Be it resolved: That the American Society of Mammalogists is opposed to control of coyotes in Yellowstone National Park, and all other National parks. The Society recognizes that in Yellowstone National Park, studies now in progress indicate that numerous coyotes reared in the park establish themselves outside of the park's boundaries. If the coyotes move thus in significant numbers, means should be found to eliminate, if necessary, the migrants after they leave the park. The integrity of Yellowstone National Park, the greatest wildlife sanctuary in America, can and should be maintained intact for the benefit of all of the people.

Be it resolved: That the American Society of Mammalogists is strongly opposed to Section 6, 81st Congress, 2nd Session, S. 3409: "A bill to establish the Wyoming Jackson Hole National Park in the State of Wyoming, and for other purposes." Section 6 would open portions of the present Jackson Hole National Monument to licensed hunting of elk. The Society strongly favors the exclusion of public hunting from the National Park System. If Section 6 of S. 3409 becomes law, the disastrous precedent of permitting public hunting in a unit of the National Park System would be established, which later would be extended to other units with far-reaching effects on the policy of preserving all species therein in their natural relationships. Regulation of the elk population should be accomplished outside of the proposed Wyoming Jackson Hole National Park.

Be it resolved: That the American Society of Mammalogists expresses strong disapproval of the plan of the local Territorial Board of Agriculture and Forestry to introduce axis deer to the Island of Hawaii. If deer are introduced, their reproduction and increase will not stop until checked by starvation. That, unfortunately, would come only after much of the island's unique vegetation has been badly depleted or destroyed by deer. Disaster to the island would include the Hawaii Section of Hawaii National Park. The local Board is urged to consider the danger and folly of such an introduction and rescind the vote it has taken favoring the plan.

Whereas, many species of mammals and other animals have been acclimatized successfully by direct or indirect human effort in regions where they were not native, and

Whereas, among the aliens so established many are of economic importance, either positively or negatively, and

Whereas, there is no organized body of knowledge concerning alien animals and their effects in new environments or of the general principles that are involved in acclimatization activities,

Therefore, be it resolved: That the American Society of Mammalogists, at its thirtieth annual meeting, June 28, 1950, directs its officers to explore possibilities of having some competent agency, properly financed, conduct a broad study of animal introductions and acclimatization and publish a comprehensive report on the subject.

Be it resolved: That in view of the widespread concern over the rapid disappearance of our native fauna, as a result of increased human occupation of the land and accelerated exploitation of our total environment, we, the members of the American Society of Mammalogists, assembled in annual meeting at Yellowstone National Park on June 28, 1950, earnestly appeal to the United States Fish and Wildlife Service, to give consideration to the following recommendations:

1. The predatory animal and rodent control policy of the federal government is the outgrowth of early control methods devised to give relief to agricultural and sportsmen's interests at a time when there was ample unoccupied land where such so-called troublesome specimens might survive. Today we are faced with the threat of complete removal of certain species from the American scene, under the traditional control policy built up

through the years. We urge that this policy be changed to meet the present day crucial situation.

2. We submit that our wildlife belongs to all the people, and all the people who have interest in our fauna and flora should have representation in the formulation of government policy.

3. Our fauna and flora, together with our scenic resources, have a wholesome appeal, and have important scientific, educational, and recreational values deserving our utmost efforts to preserve them for all time.

4. In all publicity emanating from government sources, these beneficial aspects of native animals should be stressed, in reasonable proportion with propaganda against those which cause economic damage, so that interests of all groups of people, as well as the animals themselves, might be given fair consideration. Specifically, we submit that certain carnivores and rodents being as important in our fauna ecologically and esthetically as the raptores and certain game birds that become troublesome at times, should be given equal consideration.

5. Since administrative personnel is the key to governmental policy, may we suggest that those persons for whom a control policy here suggested is congenial be placed in the strategic positions of the control operations.

6. We are in great need of ecological information on animals requiring control. We strongly recommend that the research program of the Fish and Wildlife Service be greatly expanded; that funds from the control appropriations be applied in liberal quantity to research on troublesome animal species. Such research should directly stress development of repellents, biological controls, and management practices that tend to prevent depredations. Our techniques for destruction are adequate. We need techniques for living successfully in association with our native fauna and flora.

7. We urge that the U. S. Fish and Wildlife Service establish close relationship with scientific and conservation societies, on a basis similar to that which is now developing between certain societies and the National Park Service and Forest Service. It may be desirable to maintain a person or committee of the Fish and Wildlife Service for direct liaison with such organizations for consultation on problems that arise.

COMMENT AND NEWS

CAHALANE APPOINTED SOCIETY DELEGATE

President Storer has appointed Victor H. Cahalane as the delegate to represent the American Society of Mammalogists at the meetings of the International Union for the Protection of Nature. Meetings will be in Brussels October 18–23, 1950. After the Brussels meetings, Mr. Cahalane plans to spend four months in South Africa where he will study the parks and other reserves and make recommendations for the protection and management of wildlife therein. On his way home from South Africa, Cahalane plans to visit parks in the Belgian Congo, Kenya, Italy, Switzerland, and England.

CORRECTION

An error in my paper "Calculation of size of home range" (Jour. Mamm., 30: 1–18) has been called to my attention by W. Howard McCarley of the University of Texas. Correction is by substitution of 11.0 for 10.9 on page 8 in line 7, in Fig. 1, and on page 9 in line one.—Don W. Hayne, *Michigan Agricultural Experiment Station, East Lansing, Michigan.*

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